THE

PRACTICAL MAGAZINE

NEW SERIES.—No. 32. VOL. 7, 1877.

SIR JOSEPH DALTON HOOKER, M.D., C.B., F.R.S., F.L.S., D.C.L., F.G.S. OXON., LL.D. CANTAB., AND GLOTT.

BOTANY has become an indispensable requisite in the perfect education of men of practical science. It is a science of life, and that characteristic alone bestows a position that is superior to many departments of knowledge. The truths and facts appertaining thereto are readily proved by living illustrations which admit of no disputation. Botany meets the general student at every turn. He seeks acquaintance of chemistry; he must pass an examination in botany: if he devote himself to medicine, or art, or construction, he will be at great disadvantage if he does not possess a considerable acquaintance with the properties, forms, and materials which are solely in the domain of botany. Sir John Hawkshaw's first and later labours, as shown a few months ago in this magazine, owe their success to his early studies in this interesting natural science.

Sir Joseph Dalton Hooker belongs to every domain of science. His distinguished father, after eighty years of as honourable a career as often falls to the lot of man, has left a fame that is imperishable, and his son, of whom we have now to speak, is not unlikely to excel even his father, Sir W. Jackson Hooker. Already he has had some years of presidency of the Royal Society, and many others enrol his name among their members. He bears a name in his first titles that stamps him with honour and gives his contemporaries hope. No one who has read the life of Joseph Dalton, even in the sketch which appeared in the

Practical Magazine last year, can fail to recognize the intimacy between Sir W. J. Hooker and the founder of Owen's College, Manchester, out of which intimacy came the Christian name of the present Sir Joseph Dalton Hooker. Identified with science in all its most learned members and associations, and trained up in connection with all the advanced scientific thought of his age in its most intelligent representations, he has been able to exercise those noble gifts of nature and inheritance bestowed on him in an individual career at once honourable, powerful, and of practical utility.

Joseph Dalton Hooker was born in 1817, and in early life entered on the profession of medicine; but the attraction of his father's example caused him to relinquish his idea and devote himself to the following of his father's footsteps. Sir W., in 1809, at the age of twenty-four, went out to Iceland for the purpose of exploring the natural productions of that island, and made large collections and drawings. This he undertook at his own charge (having inherited an ample fortune), and he did it at the suggestion of that eminent man, who, like a great many others, are being forgotten in the vanity and self-praise of our own generation—Sir Joseph Banks. He became Regius Professor of Glasgow soon after his return, where he won the affections of every one. A native of Norwich, he found no difficulty in winning the affections of Scotchmen, although placed in authority; and thus he gave denial to the ordinary vulgar prejudice or slander concerning the clanishness of our northern brethren. Knighted in 1836, he obtained in 1841 the control of Kew Gardens, from whence dates a well-earned career of honour.

There was a design in this appointment on the part of the friends who were instrumental in its obtainment. Sir Joseph Banks, Captain Flindar, Allan Cunningham, Mr. Robert Brown, and others, had, by the publication of their exploring voyages all over the world, raised a storm of indignation, that while England's sons were doing so much individually, and scientific societies were expending their very moderate incomes, in the acquisition of specimens illustrating the productions and the varieties of nature, the Royal Botanic Gardens at Kew were a disgrace to the country. A report was ordered by the House of Commons, Dr. Lindley being commissioned, and the reform of the institution commenced its practical work in twelve months from that date. Dr. Hooker's father's first act was to urge the free admission of the public daily to the gardens and plant houses, with what success a subsequent return will show. In 1841 the annual number of visitors was 9174; in twenty years it reached more than half a million.

Such a father deserved the son he had, and such a son will proudly honour so good a teacher.

Joseph followed his father's steps. He left medicine, took up with botany, and his zeal and successful study led to his appointment as assistant-surgeon to the celebrated Antarctic expedition which went out under the command of Sir J. C. Ross, the commander who did the greater part of what was done in the name of Sir John Ross, in the Arctic regions, and who, if any one did, discovered the magnetic pole, without gaining the credit of it.

The expedition had for its object the investigation of the phenomena of terrestrial magnetism, and the ships *Erebus* and *Terror* sailed from Chatham on the 29th September 1839, with strict injunctions on the officers to use their utmost intelligence in collecting the various objects of natural history in those absolutely unexplored regions. From the Cape of Good Hope they entered the unknown. Wild rocky volcanic islands and a few seal-catchers were all the incidents, and nothing but confirmatory evidence of Captain Cook's reports could be gleaned until they reached Auckland Islands, and there but little. They put in at New Zealand to rest, and in 1841 went on a second exploring voyage, which took more than two years, and yielded a rich harvest of knowledge, such as had never been possible to acquire before, and which has had no superior since. The region is almost entirely sea, and the islands practically uninhabited. The volume of the botany of the Antarctic Regions contains eighty 4to engravings, coloured, of plants and flowers in that region which never could have been planted or disseminated by man, and are both rare and beautiful; indeed, most of them are new to us.

As might be supposed, this extraordinary publication from the hand of the surgeon placed Dr Hooker in the first rank of scientific observers, teachers, and discoverers. A young man of 25, and a medical man, issuing such a book indicated that in the new comer there dwelt the spirit and enterprise of the father who thirty years before had journeyed in the Arctic Regions on the same errand. Consequently, in 1847 he was enabled to issue a second volume containing the *Flora Antarcticæ*, as the other only described the island vegetation. This is a grander book: it contains 200 full-page coloured engravings; is purely botanical, both in letterpress and drawing: but by and by, when those plants have to undergo chemical investigation for their utilization in the service of man, Dr Hooker's elaborate and most minute descriptions will be of incalculable value. When we say that these volumes are sold at more than forty pounds, and that it took eight years at home and abroad to arrange his materials after the toil of their collection; that the expense was borne by himself and his father—his father of course doing the outfit and instruments solely—the rest was jointly contributed with the assistance of some of the colonists; and that Hooker, to effect this great work properly, declined promotion in the Royal Navy, we cease to wonder that when in after years an upstart fourth-rate member of the Government attempted to beard him, he turned round at last, not doubting that the country he had so self-sacrificingly served would see in his service some grounds that his opinions on botanical management were of more value than those of an ill-condition and disappointed M.P. for Tower Hamlets.

In these eight years Dr Hooker had contributed two papers to the Geological Society on a subject partly within the scope of his chosen studies and partly different. They were upon the structure of coal fossils, and upon the contrast of vegetation of the carboniferous period and our own time. He had accepted a Government appointment as botanist to the Geological Survey, which was carried out with such astonishing success by Sir Henry de la Beche, and his report appears in the 2d part of Vol. 2 (1848). Without entering upon so purely a geological subject, we may offer a word of admiration at the exhibition he makes here, as in all his work—in which, again, he is but a repetition of his father's manner—the anxiety to remove hindrances from the path of young students. After pointing out the comparative ease with which a young geologist can declare the name and class of the animals, at one time existing in a district, by the fossil bone he may recover, he is at a dreadful loss to do so in regard of vegetation, for the "record of the rocks" is both scanty and defaced. "It is with a view of instructing such inquirers," that he offers counsel by describing "the first impressions of a naturalist, who, having been almost exclusively occupied with an existing flora, is called upon to contrast it with the fragmentary remains of another flora, whose species are, without any exception, different from those now living, which represent in part the vegetation of a period infinitely antecedent to the present, and have been succeded by still other plants, equally diverse from both, and which have likewise perished." The paper is a marvel of instruction, and ought to have a separate and revised reproduction. It is what it professes to be, a statement of principles that ought to govern the geologist and the botanist in their mutual desire to aid each other; and an attempt to define the essential differences that clearly manifest the existence of separate scientific systems in the order of nature, which one after another have passed away and left no kind of connection, not even of general principle, with the order we are conscious of. He then discourses on the probable extent of the flora of the coal formation in Great Britain in about 40 pages, illustrated with botanical and other drawings.

A second paper on Fossil Botany followed, especially in reference to petrified cones, in which he re-proves his former hypothesis.

Sir William had succeeded in obtaining the consent of the Government to an expedition through our Indian possessions, especially the Himalaya regions, in the interest of Kew Gardens, and many are the acclimatized specimens in those gardens the fruit of this expedition. It was placed under the control of his son, the subject of this notice, and was published in 1854.*

This journey had the kind interest of Baron Humboldt, and was in its incipient stage the product of the young adventurer's own mind. "Having accompanied Sir James Ross," he writes, "on his voyage of discovery to the Antarctic Regions, where botany was my chief pursuit, on my return I earnestly desired to add to my acquaintance with the natural history of the temperate zones more knowledge of the tropics than I had hitherto had the opportunity of acquiring."

Taking out a commission from the Crown to collect for Kew Gardens, he accepted a salary of £400 a year for two years. He accordingly proceeded thither, and continued an extra year, making the friendship of the excellent Mr. Hodgson, so well known by his contributions to our literature concerning Buddhism, the affinities, laws, languages and customs of the Himalayan tribes, and by his extraordinary collection of specimens and drawings, all absolutely new to the western world.

Nothing could have conduced to the fulfilment of Dr. Hooker's purpose so much as to have made that friendship; and, like a wise man, he "bettered the instruction." A more enchanting book cannot be than the 2 vols. of Himalayan Journals. It tells of

* Himalayan Journals; or, Notes of a Naturalist in Bengal &c., &c. By Joseph Dalton Hooker, M.D., R.N., F.R.S., with maps and illustrations. 2 vols. London: Murray.

physical geography, botanical matters, and every form of natural history with all the rapture of a shrewd, light-hearted, and highly intelligent traveller. There was not of course much of what we especially seek for—practical mechanics, or the practical uses of the products of nature, but the foundation he laid has been sound and is bearing the process of edification satisfactorily. He met with a suspension bridge when journeying toward Junnoo Peak, which is 25,312 ft. above sea-level and capped with snow, and says that in such bridges the principal chains are clamped to rocks on either shore, and the suspended loops occur at intervals of 8 to 10 feet; the single sal-plank laid on these loops swings terrifically, and the hand-rails not being four feet high, the sense of insecurity is very great. In Bhaguepore he found large horticultural gardens and many English plants growing there to the benefit and healthful occupation of the English and native residents. He massed much information on geology which had a peculiarly important bearing on many of the points of controversy in that mysterious and as yet but partially known science.

In his father's "London Journal of Botany," vol. 7, are his letters describing their voyage out, interspersed with exploring researches wherever the ship could land. Lisbon, Mediterranean islands, Africa, Egypt, where, at Cairo, he had the vile Turkish baths to perfection, of which, with everything else, he gives a vivid and most amusing description. In style of composition, Dr Hooker is a model for travellers. There is not a forced word or one too many; and it would appear that the reader beholds all the travelling naturalist saw and all he did. Kew has plenty of the stock derived from the voyage out, as well as that vast store collected in the Himalaya regions.

After being in India a little time, the late Lord Auckland obtained Dr Hooker's consent to the examination of Borneo, with a view of ascertaining what natural products in that island were of commercial value; the object being to make an industrial colony of what hitherto had been a nest of pirates. Government sanction he had secured, but the hand of death removed that enlightened nobleman from earth; and this project, like many others of wonderful foresight and beneficence, had to be abandoned.

The chivalry of the botanist shone conspicuously in the sacrifices he made. All the results went to Kew Gardens—a treasure to the nation and the best trophy it had ever been permitted to receive; but the cost exceeded by a thousand pounds the vote of Parliament warranting the enterprise. This charge he bore at his own cost. Father and son devoted their industry, genius, time, energy and fortune with the utmost assiduity to the national service. Upon his return from India he joined his father at Kew with all the filial affection nature demanded and intelligent admiration could inspire: for these services he sought not, nor did he receive, any remuneration from the public purse; and for the nine years which the arrangement of his data and specimens occupied, undertaken at the request of the Admiralty, he only received his official navy pay of 3 years with a grant of £500. We do not call in question the conduct of the authorities; we only point out that such circumstances do not tend to benefit the public interest. Had Hooker been a man of straitened means it is very doubtful indeed whether the store he has gathered would have been obtained at all; and certainly not for his country. Enthusiasm does more than duty: but enthusiasm looks for the ordinary supplies of the necessaries of life.

In 1855 he was requested to assist his father officially, and became Assistant-Director of the Botanical Gardens at a salary of £400 a year without residence, which in three years grew to £500 a year with residence.

On the 12th August 1862, that venerable father went away in his 81st year, and in three months the son received an official communication that he had been nominated successor to his father as director, but without an assistant. This, like the conduct pursued to Sir W., was too bad. Mr. Aiton retired in 1841 on a pension of £1,000 a year; and the new man, worth a dozen of his predecessor, is compelled to take £400; and after he had thrown open the place to the public and added thousands of objects to the stock, founded the museum and popularised the whole place, he never received anything like the retiring pension of one who really was a nonentity. We have above referred to the effect on the number of visitors in Sir W.'s time, but now visitors make a total of about two millions a year. If Mr Aiton was entitled to a pension of £1000 a year when only 10,000 visited the place in a year; when it was not half planted; when it had no museum; where is the sense of honour and the idea of honesty in authorities who give half the retiring money of the one to a successor who has spent private means without stint and multiplied the public interest two thousand fold? The ends of the earth have been ransacked—Africa, India, and Egypt; Morocco, and the islands of the Pacific; the educational power of the royal grounds has been made the most useful, as it is physically the most recreative, of places; the school of gardeners is a nursery for horticulturists, who, departing thence, go to turn wildernesses into gardens, and deserts are compelled to blossom with new grace; the museum is an everlasting and infinite source of instruction to all persons, young and old, who have eyes to see and sympathies common to mankind. And yet with all this heritage of renown and claims upon national affection, an attempt on the directors' authority had the direct inspiration of the chief commander, Mr. Ayrton, a member of Mr. Gladstone's government. The Premier had nothing to do with that controversy; but to show the serious aspect it assumed, we note that the remonstrance against the arbitrary interferences of mean authority were addressed not to the office but to the Premier, and bore the signature of Sir Charles Lyell, Sir James Paget, Professor Tyndall, Professor Huxley, and, in their official capacity, all the presidents of one of the great literary and scientific societies. The guardianship and conduct of the Kew establishment passed absolutely out of the interfering power of the subordinate official into the creative hands of the Hooker family; a public scandal was averted. Dr Hooker was knighted, and now occupies with great advantage to the nation a public trust and position which it is indeed to be desired he may continue to hold with the devoted affection and zeal which characterized his early and his middle life.

The friend of Dalton, Faraday, Stephenson, and the illustrious *savants* just named, deserved this humble recognition from all those who are devoted to the search after truth, who, believing in the universality of truth, feel that all fearless searching inquirers who are meek and bold, kind and true, deserve to be counted in the ranks of practical men of the first degree.

But a notice of Dr. Hooker without a word about Kew Gardens would be incomplete. That excellent collection is the monument of the Hooker family as much as St Paul's Cathedral is that of Wren. As in the order of nature to which their lives, studies, and affections are devoted and their interests involved, these men have sown seed that will never cease to be reproductive, redounding in the result to their personal honour, and entailing on generations to come their grateful obligation. The inner life of the men appears in every part of those national grounds. They created its present life, and have been endowed with wisdom in the selection of coadjutors worthy of their fellowship, to extend operations too great for one mind to control. Any one who has visited that beautiful Museum could not, for instance, ignore the collection of wood specimens formed by Professor Henslow and bequeathed by him. In itself it claims the admiration and excites the astonishment of every visitor. Beauties of nature indeed they are; and must have cost their collector years of care, study, and labour. The life of Gilbert White is one of the sacred biographies of England; and that of Professor Henslow is of equal purity, wisdom, and simplicity. By sheer affinity he became associated with Sir J. W. Hooker, and by that same law all that Henslow possessed came to be under the control of the nation. The contributions of Professor Henslow to Kew through this association are unique. There is not only the wood, showing the grain of every known tree, which, as so placed, is of incalculable value to the artist whose vocation it may be to imitate by his brush and comb and turps the various beautiful forms of timber grain; but to the naturalist he has given as much; and to those whose honour it is to have the charge of a rural parish it would be exceedingly difficult to expose a finer model than that of the Rector of Hitcham. Sir James Hooker's son married the daughter of Professor Henslow; and in the spirit of the ancestry the work at Kew Gardens has been continued.

The public has little knowledge, and perhaps less concern, as to the material assistance and provision that its demands require; and as they look on trees and squares, avenues and terraces, heed not a jot on the thought of how these are furnished. The national trustee of Kew Gardens is in duty bound to provide these trees, and see that they are of the required sort, healthiness, and age, required to ornament at a week's notice any part of Her Majesty's royal parks or the public avenues. Kew has to find all this. It is nobody else's business but that of Kew to provide for these demands; Hyde Park takes a half-dozen plane trees of 14 feet in height and as many elms; Battersea demands five planes and a dozen elms, and Victoria is just as greedy. Kew finds them all. Holiday folk take the boat from Chelsea and delight themselves through the medicine of eyesight, but how few look upon it as the nursery of all our national arboretical ornaments. Year by year this goes on, and must go on so long as the spirit of Hooker remains in possession.

Then turn to the Botanic Garden. Englishmen have little thought concerning the method and labour undertaken by their country when entrusted with the supreme control of rebellious or antagonistic races. They are now dying of drought that ought not to be; and in many parts they want trees not only to attract moisture but to attract rain. The people on the one side and those on the other bitterly complain. And why? because they have not the advantage of what is well known; and because what is well known could not be by everybody wisely under-

stood. From Kew Gardens there was flourishing in Madras 3477 plants of the Red Bark of South America transported; and Englishmen did not care for such specimens of natural regard, because they had not come to the knowledge that these wondrous productions belong to mankind. They little recognised the idea that unto them it was given to send out to the nations beyond the seas, and to those who in any case looked to us as the *purchasers of their riches* and the *suppliers of their wants* for those lovely and profitable ornaments to their gardens and their farms: they did not understand that the whole policy of England was giving, in the probability and little hope of receiving: they little knew that when Dr Hooker sent out his plants he supplied some wants they knew not who would require. And Dr Hooker knew quite well that if England did not supply others, no one else could! He was the servant of the Ministry who sought to return to the world, in their political capacity, some acknowledgment of the vast obligations and the imperial responsibility of this generation in regard of the governance of the soil and the multitude: that unto us "the ends of the earth had come," that we possessed a trust which to our honour or our eternal disgrace must remain for the vindication of our policy, or for our personal contempt as Englishmen on the face of the world.

And so we look at this question. Dr Hooker has excelled his excellent father in the management of the national trust: he has made that trust become a guardian of the interests of all civil servants; he has done all that could be done to develop our colonies, or to aid our provincial public parks. Surely, while we review these great changes of botanical policy, and know by what ancestry and by what men they have been accomplished, we can learn to be kind and wait in sure and certain hope.

W. S. C.

THE EARLY HISTORY OF THE RAILWAY GAUGE.

PRACTICAL men are anxious when a dispute arises about a fractional part of an inch, and it is not surprising that when the statement of one well-qualified to know sets down the original railway gauge at 4ft. 8in., and another challenges him by stating that it was 4ft. 8½in. That this dispute has arisen and been hotly contested may be supposed: men of science cannot, even in common life, be other than accurate, and the accuracy in this case culminates in the vindication of the first reports and patrons. These are the particulars as communicated by Mr. Manhall.

The Stockton and Darlington Railway, which was opened in 1825—the fiftieth anniversary of its opening having been recently celebrated—was made 4ft. 8in. gauge inside the rails, and 5ft. gauge outside the rails, these being 2in. width, of wrought iron, rolled fish-bellied, with half-lap joints, and weighing 28 lb. per yard; a small portion of the line was laid with cast iron fish-bellied rails. A specimen of the original wrought iron rails is upon the table, which has been kindly lent by Mr. John Anderson, of Middlesbrough. This gauge of 4ft. 8in. inside, and an even 5ft. outside the rails appears to have been at that time, and for a long period previously, the regular gauge for the colliery tramways worked by horses, that being the gauge of the chaldron coal wagons in general use; and when locomotive engines were introduced, they were consequently made the same 4ft. 8in. gauge. The original engine that opened the Stockton and Darlington Railway, named Locomotion, which was made by George Stephenson at Newcastle, and is now preserved at Darlington station, was made 4ft. 8in. gauge, and remains so at the present time, the gauge between the wheel tires being 4ft. 5in.; the tires are cast solid with the wheels.

The following information respecting the Stockton and Darlington gauge has been kindly supplied by Mr. MacNay, the secretary of that branch of the North-Eastern Railway. In the original Acts of 1821 and 1823, under which the railway was made, there was not any gauge specified; but in the subsequent Act of 1828 (three years after the opening) for extending the line from Stockton to Middlesbrough, it was provided "that the distance between the inside edges of the rails shall not be less than 4ft. 8in., and the distance between the outside edges of the rails shall not be more than 5ft. 1in." This is the earliest case known of railway gauge being fixed by Act of Parliament. The 4ft. 8in. gauge continued upon the Stockton and Darlington line for fifteen years, until the opening of the main north line between York and Darlington in 1840, when the gauge was altered for the purpose of removing the obstruction then experienced in the interchange of traffic, by allowing any wagons of other railways to run upon the line; as previously, only those of the wider gauge wagons that had thin flanges could be taken on the line. The Stockton and Darlington was, however, only altered to 4ft. 8¼in. gauge at that time; the reason for not making it the full 4ft. 8½in. being that most of the wagons employed on the line were the old chaldron wagons, which were slack to the 4ft. 8in. gauge, or had excessive side play, and the line being at that time laid mostly with stone blocks, having no tie between the rails, was liable in bad weather to get wide in gauge. The subsequent alteration to the present full 4ft. 8½in. gauge was carried out gradually as the course of repairs and the relaying of the line gave opportunity; and this alteration was greatly facilitated by the circumstance of the rails being laid on blocks, and not tied together by transverse sleepers as in the later construction of permanent way.

Information has also been supplied by Mr. Carson of the North Eastern Railway, Stockton, respecting the Clarence Railway in the same neighbourhood—opened in 1838 for passenger traffic by locomotives, and previously worked by horses—that the gauge was originally 4ft. 8in., and this was altered to 4ft. 8¼in. about 1842, and the gauge was subsequently made 4ft. 8½in.

In reference to the gauge of the early colliery lines previous to the making of the Stockton and Darlington Railway, the following information has been supplied by Mr. Cuthbert Berkley, of Gateshead, manager of the Marley-hill and Springwell Collieries, Newcastle. The Springwell Colliery Railway, one of the oldest in England, was laid to 4ft. 8in. gauge, and this was only altered about 1854, when the Springwell line was connected to the Marley-hill and other collieries, which were already in connection with the North-Eastern Railway. The difference of the gauge was then found out by running the North-Eastern Railway wagons over the Springwell line; the wagons would run, but the gauge was found very tight, and the platelayers' gauges were consequently altered from 4ft. 8in. to 4ft. 8½in., and the new wagons afterwards put on the line were made for the 4ft. 8¼in. gauge.

The Liverpool and Manchester Railway, which was the second public railway, was opened in 1830, five years after the Stockton and Darlington; and the conclusion drawn from the information received is that it was commenced at the Manchester end on the same gauge of 4ft. 8in., being laid by platelayers taken from the Stockton and Darlington, and using their old gauges. In reference to this the following information has been received from Sir John Coode:—"It was stated to me personally by Mr. George Stephenson, that when the platelayers went from the Stockton and Darlington to the Liverpool and Manchester line, they took their gauges with them as parts of their stock of tools, and these gauges were used as a matter of course in laying the rails." The original engine, the Rocket, that first run upon the Liverpool and Manchester line at the competition in 1829, for determining whether locomotive or stationary engines were to be adopted for the working, was made 4ft. 8in. gauge, as shown by evidence preserved at Messrs. Robert Stephenson and Co.'s factory, Newcastle. During the progress of the line, however, the gauge was settled to be 4ft. 8½in. The following information on this subject has been supplied by Mr. Thomas L. Gooch, of Saltwell, Gateshead, who was engaged in the construction of the Liverpool end of the Liverpool and Manchester Railway under Mr. George Stephenson:—"There was much discussion during the construction of the line about curves and the self-acting value of the conical tire in relieving the pressure of the flange against the rail, and the consequent need of a certain amount of play in the gauges of wheels and rails; especially as considerably higher speed was contemplated (even before the 'Rocket' was produced) than that on the Stockton and Darlington Railway. I venture to think, therefore, that the extra ½in. was given to meet these considerations, and that this was the true origin of the 4ft. 8½in. gauge."

The conical tire appears to have been first used on the Liverpool and Manchester Railway, the previous tires having been all cylindrical; and as an increased play between the rails would necessarily be required in order to give effect to the conical tire, the most likely conclusion appears to be that the extra ½in. was then added to the gauge for that purpose, thus increasing the original 4ft. 8in. to the present 4ft. 8½in. gauge.

The same gauge as the Liverpool and Manchester Railway, 4ft. 8½in., had to be used for the Grand Junction and the London and Birmingham railways, forming the through communication which was opened eight years later—in 1838—from the Liverpool and Manchester line to London; and 4ft. 8½in. became consequently established as the standard dimension for the gauge.

In several of the succeeding railways, as in the following list, the original gauge was increased ½in. more to 4ft. 9in.; but these were subsequently altered, and 4ft. 8½in. has been since adhered to as the standard gauge.

Railway Gauges.

	Opened.	Original. ft.	in.	Present ft.	in.
Stockton and Darlington ..	1825 ...	4	8 ...	4	8½
Liverpool and Manchester ...	1830 ...	4	8½ ...	4	8½
Grand Junction	1838 ...	4	8½ ...	4	8½
London and Birmingham ...	1838 ...	4	8½ ...	4	8½
York and North Midland ...	1839 ...	4	9 ...	4	8½
Birmingham and Derby ...	1839 ...	4	9 ...	4	8½
Chester and Crewe	1840 ...	4	9 ...	4	8½
Manchester and Birmingham	1840 ...	4	9 ...	4	8½
Manchester and Leeds ...	1840 ...	4	9 ...	4	8½

Some information respecting the original gauge of the Newcastle and Carlisle line has also been received through Mr. George Dove, of Carlisle. This line was in physical progress during the making of the Liverpool and Manchester, and the first portion opened was 4ft. 8in. gauge; a part of this was single line, and afterwards doubled by adding an extra rail on each side, thus leaving the intermediate space between the two lines only 4ft. 8in.

FOUNTAINS.

FOUNTAINS have been the visible tokens of wealth and luxurious dwellings, belonging to persons whose tasks were refined, who loved ease and knew how to procure the highest form of physical comfort and repose, in all countries and in all climates. Jerusalem, Nineveh, Babylon, Rome, Pompeii, Carthage, in ancient times, and in the later times the Moors, the Italian palaces, the cities and palaces of Spain, Germany, and France, all contain evidences and some of them relics of the inherent delight mankind has in beholding the mysterious action of water, and testify to the soothing influence of that wonderful element in motion upon the restless spirit of man.

Fountains are of several classes, but of one principle. They are public ornaments, they adorn the private ground of the wealthy, they are domestic in ornament and utility, and in the last forms especially are they growing in popularity and general acceptance. The Romans of the present time are perhaps the most abundantly furnished with this agreeable convenience of all modern cities, but the ancient profusion must have been at least tenfold greater. Many are highly decorated, of great magnitude, and very varied in their mode of ejecting the water, with which they are supplied from existing aqueducts. The fountains of Travi, and the Pauline fountain at San Pietro in Montorio, are immense piles of architecture, and one of these highly decorated with sculpture. Loreto has a bronze fountain in the Piazza della Madonna, ornamented with armorial bearings, eagles, dragons and tritons, the work of Calcogni's pupils. In the Piazza dei Gallia is a fountain ornamented with a dragon and four cocks. These are supplied from the aqueduct. At Perugio, in the Piazza del Sopramura, is an ancient specimen erected in the twelfth century, consisting of three basins or vases, one above the other, with curious and innumerable figures allegorical, mystical, and historic. The two lower basins are of marble, and the upper of bronze. Siena, on the road from Florence to Rome, has several, one in Gothic style, the Fonte Branda is immortalised by Dante in *Inferna*, xxx.:

> "But could the sight of Guido greet me here,
> Or Alexander's hapless soul once more,
> I'd change it not for Branda's fountain clear."

Other fountains ornament that city, notably the Fonte Gaja, the fountain of joy, because it produced that sentiment at its opening, the inhabitants having previously suffered terrible privations from the want of water. This has a wonderful subterranean aqueduct of 15 miles in length, built in the thirteenth century. The city is fine, but as Charles I. said, it is more admirable below than above ground. Viterbo, a place of venerable historic associations, has three; one the Fontana Granda is proverbially beautiful, and the other two are excellent works of art. But the Beautiful Fountain of Nuremburg has an European fame, notwithstanding the many handsome structures of the Continent. It is a Gothic obelisk or spire 50 feet high, somewhat like our Queen Eleanor crosses, and is kept in excellent preservation. Four and twenty statues carved in stone, with artistic excellence, represent the seven Electors, nine Heroes—viz., three Jewish, David, Joshua, and Maccabeus; three Pagan, Cæsar, Alexander, and Hector; three native, Christian, Charlemagne, and Godfrey of Bouillon, surround the lower part, and above are Moses, and seven Prophets.

These are the sources of water supply for domestic use. They are public water-works, but from these were laid on in the European cities, conduits to private houses, where the fountains played for ornament as well as for utility; and this modern application of water—that of pipes—which in our conceit we sometimes deem to be one of our thousand-and-one novelties won by our own science, and the product of our skill, was very well known in Ancient Rome, and indeed in Pompeii, where, also it must be confessed, have been found leaden pipes conveying water to the bath with its central jet, or to the boudoir with its enclosed glass or tile casing, sometimes or more often open.

Spain abounds in fountains, especially in the Moorish districts. The "stranger encounters them at every turn; in the public walk, the garden, the market-place, and in the private dwelling." These are supplied from a mountain river, which has been diverted by a canal, to fill a huge reservoir close over the town to be served, and as the waters rise to their highest level, these fountains form the accumulated columnal pressure, eject the waters to a very great height, and produce a glittering effect: from the force, the water sparkles like diamonds, as it splashes about in its upward and downward career, producing prismatic colours of enchanting beauty. The Modern Spaniard has his private supply, his pipe, and his tap, and in his elegant parsimony does not waste what is beautiful. The private fountain is often tiny; always graceful; and it never is allowed to be used when not required.

What shall we say of France, and its artistic charms in this regard? Fontainebleau—the Beautiful Fountain, is well known, and celebrated most deservedly. Paris has no wells, and depends on its beautiful fountains. The Chateau d'Eau is perhaps the most copious; and those in Place de la Concorde the most handsome; that of the Marche des Innocents is a specimen of Renaissance architecture and sculpture of singular attractiveness. There are a dozen others—private houses have them, but not so numerously as one might have supposed; of course, they are in proportion as plentiful as in any capital, but considering the position of Paris in the world of luxury, they are less so than would naturally be expected.

Our cold, and in some respects cheerless climate, disqualifies us from obtaining the enjoyment from public fountains, which is the happy possession of other lands. The trysting place, the gossip rialto, the scandal market, the place of display, announcement, and observation in Spain, and in Southern France, is the fountain, but it is not so in England, at least in London. Who would go to Trafalgar Square to find any of these things? But the water has the same charm for us as for any other people, and its movement is suggestive to us of innocent beauty, natural grace, and pleasing repose as to those who inhabit warmer climes. We are obliged, therefore, to obtain within doors, or under glass coverings, those lovely adjuncts to an English, or any other home; and as we have, more than any land, most perfect domestic methods of conveying water to the interior of our dwellings, all we have to do is to select the medium for its flow, small or large, rich or plain, ornamented or neat in style; these have to be considered, and whether a man be rich or not, he can have his wants gratified, at least the poor man can say, "This is not what I wish, but it shows to me, what I would have," and he perhaps has as rich a pleasure as the man of great means, who scarcely knows how to spend enough.

The fountain is a stream of a water emerging from the earth with sufficent force to carry it to considerable heights, which heights vary much according to the level of the supply from whence the water is supplied. The magnificent fountains at the Crystal Palace, Penge, derive the water from those towers which adorn the hill and signalise the locality for 50 miles round. Almost all the adult English people have witnessed the profuse display when the Great Fountains are on; and they have seen at the same time that the crystal and other fountains inside the building are none the less effective for the enormous consumption in the grounds. The principle that produces this result is precisely the same as in every other house in London or any other town, where the water supply is under the regulation of scientific men that are at the same time practical. Those who reside in houses where the water supply is placed at an elevation as great as that of the house know by experience that water will rise to the level of its origin; and knowing that, they adapt all the contrivances of their house upon the same principles as guide those who control the splendid public displays.

This is their advantage; they are not obliged to become bound to a fixed pattern; they can have variety. If their place is but 9 ft. square and only 2 ft. square of that is to be available, he must, if he desires a fountain, select such an one as shall give all the pleasure he can afford to pay for and indicate what further could and would be attainable. Now just to show how modern science has endeavoured to meet this demand, we have been favoured with a set of patterns from one of the oldest established London houses,

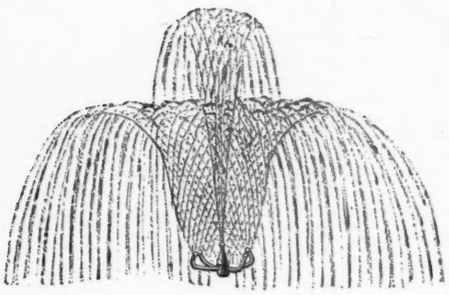


Fig. 1.

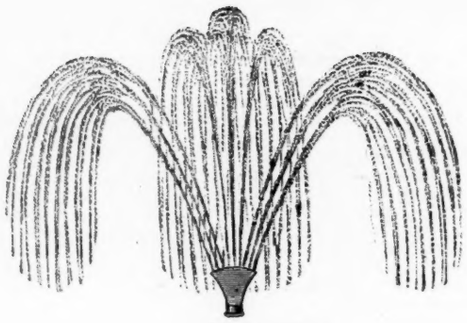
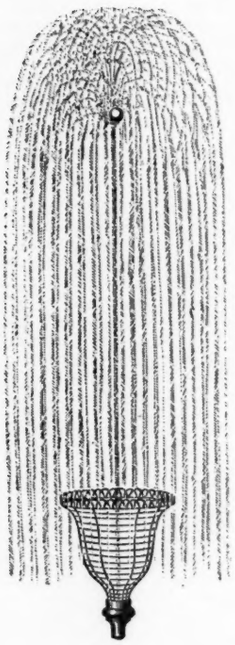


Fig 2.



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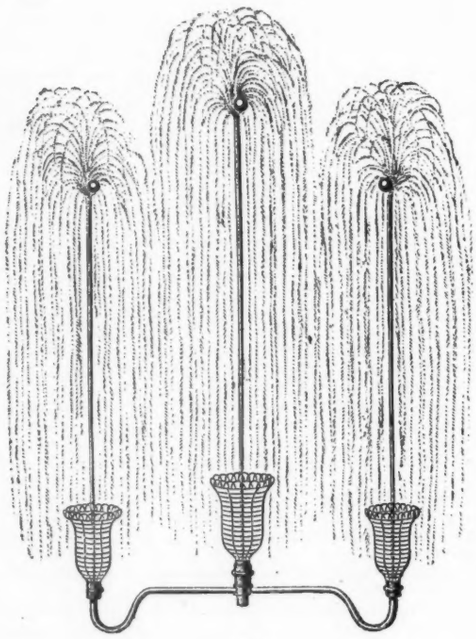


Fig. 4.

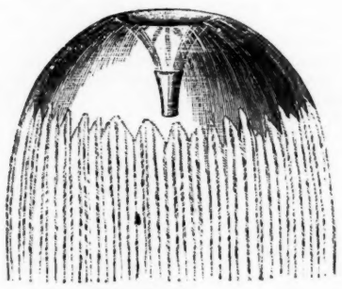


Fig. 5

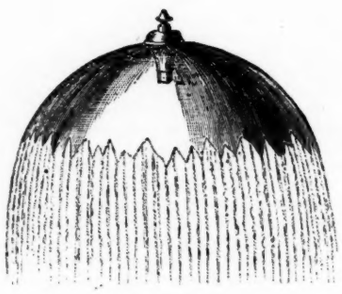


Fig. 6.

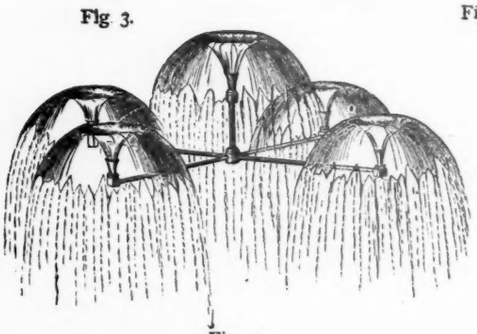


Fig. 7.

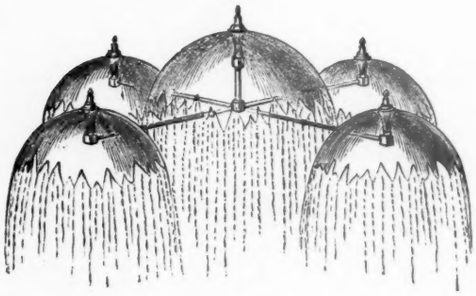


Fig. 8

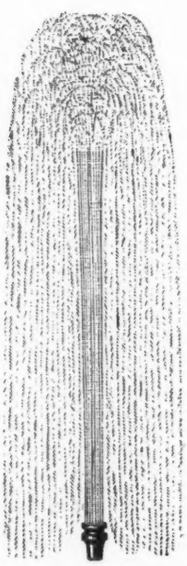


Fig. 9.

Flg. 10

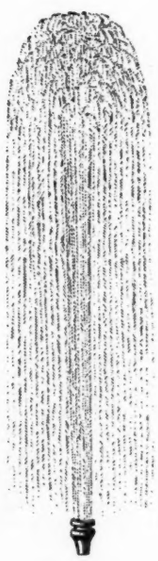


Fig. 11.

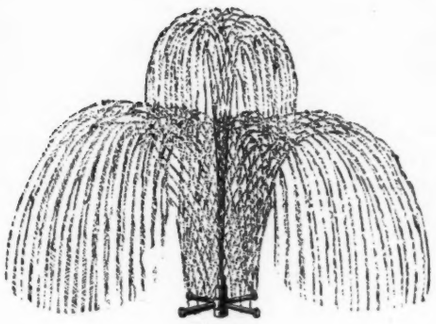


Fig. 12.

Fig. 13.

Fig. 14.

Fig. 15.

Fig. 16.

Fig. 17.

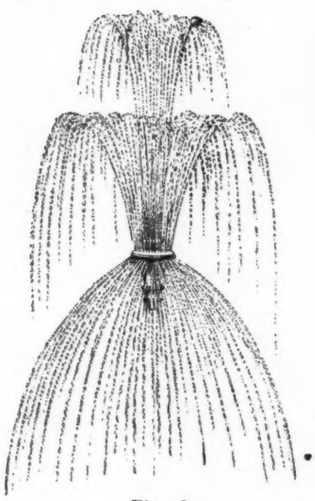


Fig. 18.

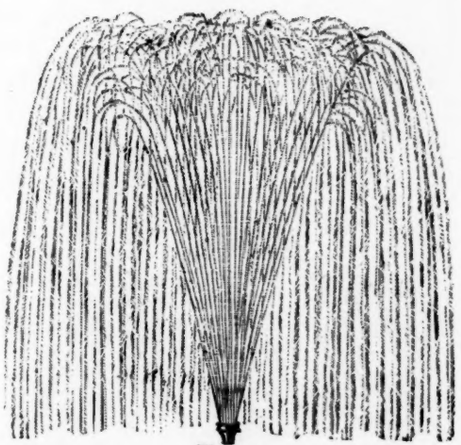


Fig. 19.

Fig. 20.

Messrs. Tylor and Sons, of Newgate Street, London. These do practically explain themselves. They are really of almost no expense, and in every conservatory or glass house besides other places they ought to be in readiness. There are other manufacturers equally respectable, and who have sought to meet the public requirements, but with the limited space in this Magazine we are glad to confine ourselves in this, as in other cases, to the productions of one house which we know to be good.

Fig. 1 is a half-guinea Mill Jet, of Barker's patent: Fig. 2 is what is known as *Fleur de lis*, or Prince of Wales Feather Jet, made in two sizes at about half that price. Fig. 3 is a copper wire Basket Jet, made in five sizes, varying from 8s. to 20s.; and Fig. 4 is the same principle trebled at a very little extra cost; the difference of form is required according as the room or glass-house is square or in the form of a parallelogram. Then follows 5 and 6, known as the Convolvulus Jet, opening at the top, whether in 1 or 5 flowers, but very elegant; the first of these is about 7s., and the latter almost three guineas. Nos. 7 and 8 are called the Dome Jet, and are about of the same value as the Convolvulus; the structure is apparently the same, but the shapes are different. Figs. 9, 10, 11, are simple elegant productions that really would, under a glass dome, adorn and not injure the best room and furniture. Fig. 12 is an enlargement of the Prince of Wales pattern; and Fig. 13 a combination of the Dome and Convolvulus Fountain Jet in a cheaper form. Figs. 14 and 15 are Rose Fountain Jets, the first single, and the next three-fold; Figs. 16 and 17 are on the same patterns, but the first is fourfold, and the last larger. These are combined in the Double Rose and Fall Fountain Jet, No. 18. The Mist Jet, No. 19, at about 5s., is a plain and pleasant form that is fit for a conservatory, because it dispenses but little water and is almost a vapour. Venus in the Mist (No. 20) is the same idea enlarged. The last figure is that of the double revolving jet, which is a very agreeable pattern, especially when the sun is shining upon the glass or on the lawn.

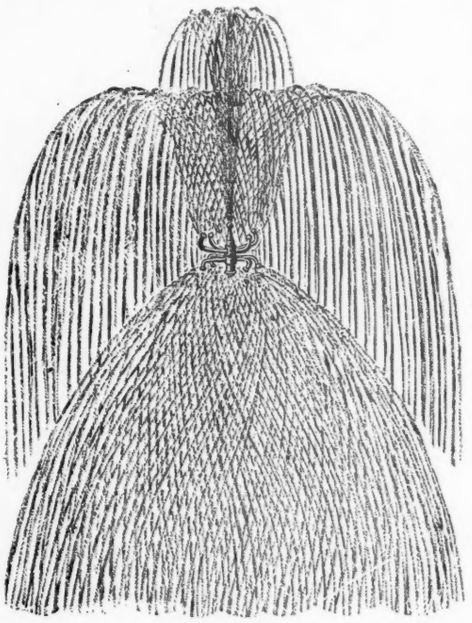


Fig. 21.

Now it is due to the reader and to ourselves to say that in thus illustrating the forms of fountains and commending their use we have but one object in view, that of enhancing the charms of home and increasing the attractions and endearments of that abode of innocence from which men get their aspirations, women their delightsome employments, and children their affections. Messrs. Tylor have at our request greatly obliged by allowing us the use of their patterns. We will hope that modern England will be aided in its emulation to excel ancient Rome, not only in the valour of their sons, but in the elegance of their homes.

THE BOARD OF TRADE'S REPORT AND ORDER ON CONTINUOUS BRAKES.

JUST sequence to the report published in our journal for June, appeared on the 30th of August in the form of a circular, addressed, on the part of the Crown, to the Railway Companies Association. Twenty of our chief lines had responded to the request of the Government, inquiring what steps had been taken to fit continuous brakes to passenger trains, and it was found that the influence of prejudice, interest, patronage, or conceit, culminated in the absolute refusal to adopt a uniform system. This arrogance has received the following rebuke and order:—

Sir,—I am directed by the Board of Trade to request that you will call the attention of the directors of your company to the paper which has recently been laid before Parliament containing the correspondence that has taken place between the Board of Trade and the Railway Association relative to the use of continuous brakes, and to state that this department have been giving further careful consideration to this important question, as will be seen by a reference to the general report upon railway accidents for the year 1876, recently presented to Parliament.

In that report will be found the details of the circumstances attending all the accidents which have been investigated by the officers of the Board of Trade during the past year; from a careful examination of which, and similar information for the past few years, the Board of Trade are led to conclude that three-fourths of those accidents might probably have been avoided, or the results materially mitigated, if the passenger trains concerned had been provided with continuous brakes.

In Mr. Leeman's letter of the 18th April forming part of the correspondence above referred to, it is stated that it is "not essential that one form of brake should be invariably adopted." If by this it is meant that it is desirable to try every form of brake, and that it is not desirable by the exclusive adoption of one form to prevent the trial and introduction of better forms, the Board of Trade would entirely concur. But if it is meant that there would be no advantage in having one form of brake for all lines which interchange traffic with one another, the Board of Trade hold a different opinion; for it appears to them obvious that in the interchange of rolling stock, including ordinary carriages, saloon and family carriages, horse boxes, carriage and fish trucks, and other vehicles forming part of passenger trains, between one line and another, if the brake fittings are not similar, the efficiency of the brakes must be proportionately impaired, and that this must be especially the case where the lines of two or more companies are continuous.

The London and North-Western, the Great Northern, and the Midland Companies all run through trains to Scotland, which are forwarded over the Caledonian, North-Eastern, North British, Glasgow and South-Western, and Highland Railways. It is, therefore, obvious that the advantage to be derived from any continuous brake system in use on any of these lines will be diminished and neutralised, if at such stations as Carlisle, Glasgow, York, Edinburgh, Perth, and Inverness, the traffic is so arranged that carriages with one system of brakes are attached to trains containing carriages fitted with a different system. This evil can only be avoided if those companies which interchange traffic with one another adopt one and the same general system.

The Board of Trade, therefore, regret to observe from the returns forwarded in the correspondence above alluded to, not only that there is no immediate prospect of the adoption of any such general system, even by companies owning continuous lines, but that many of the companies are not taking, and apparently refuse to take, any steps towards that end.

Referring to the merits of the different brakes now in use, or under experiment, as stated in the answers to the questions put by the Board of Trade, it is to be remarked that the statements of the different companies vary considerably, and are scarcely consistent with each other. Thus the London and North-Western Company express themselves satisfied with a mechanical continuous brake, which is reserved for cases of emergency, and which can only be applied throughout the train by the engine drivers or guards, through the intervention of a communication cord. No other great company appears to have even tried this brake. On the other hand, many companies speak in the highest terms of air or vacuum brakes, which are rejected *in toto* by the London and North-Western Company. The Great Northern Company have adopted a vacuum brake which is highly thought

of, and which, it is stated, can be made self-acting, but which, so far as can be learned from the correspondence, does not at present possess that quality. The Midland, North-Eastern, North British, and some other companies, are stated to have tried or adopted brakes which are self-acting. On the other hand, the Manchester, Sheffield, and Lincolnshire Company seem to think that new elements of danger are produced by the practical operation of continuous brakes, though they do not say what those dangers are. It would be easy, but is scarcely necessary, to dwell at greater length on the different, and even discordant, views disclosed in the answers of the different companies. Under these circumstances the Board of Trade, whilst recognising the efforts which some of the companies are making in testing or adopting improved systems of brakes, cannot regard the state of things shown by these papers as satisfactory, inasmuch as it indicates a diversity of opinion and action, and in some cases an absence of progress, which, if allowed to continue, will be most injurious to the character of the companies, and to the interests of the public. There has, apparently, been no attempt on the part of the various companies to take the first step of agreeing upon what are the requirements, which, in their opinion, are essential to a good continuous brake.

In the opinion of the Board of Trade these conditions should be as follows:—*(a)* The brakes to be efficient in stopping trains, instantaneous in their action, and capable of being applied without difficulty by engine-drivers or guards. *(b)* In case of accident to be instantaneously self-acting. *(c)* The brakes to be put on and taken off, with facility, on the engine and every vehicle of a train. *(d)* The brakes to be regularly used in daily working. *(e)* The materials employed to be of a durable character, so as to be easily maintained and kept in order.

The inquiries and experiments instituted by the Royal Commission on Railway Accidents, and the recent researches into the causes of railway accidents during the last few years, appear to the Board of Trade to leave no doubt as to the importance of the above conditions, and the experience which has been obtained by the companies appears sufficient to enable them to come to some general and unanimous conclusion. There can, therefore, be no reason for further delay; and the Board of Trade feel it their duty again to urge upon the railway companies the necessity for arriving at an immediate decision and united action in the matter. The companies and their officers who are as much interested as the public in the safe and efficient working of their railways, and upon whom devolves the adoption of proper systems of brake and of such other improvements as have been proved by past experience to be necessary in the interest of public safety, would do well to reflect that if a doubt should arise that, from a conflict of interest or opinion, or from any other cause, they are not exerting themselves, it is obvious that they will call down upon themselves an interference which the Board of Trade, no less than the companies, desire to avoid.

In conclusion, I am to call your attention to a notice which has already been given in Parliament for next session, for copies of any further correspondence between the Board of Trade and the railway companies with reference to the progress made in brake power; and in order that the Board of Trade may be in a position to furnish that information to Parliament, I am to request that the companies will from time to time furnish the Board with full accounts of any further experiments they may make, and of any steps which they may take for the adoption or extension of improved systems of brakes.—Your most obedient servant, EDWARD STANHOPE.

FLOATING DOCKS.

IN our last we were able to publish an extended notice of the great floating dock constructed for the Russian Government by the distinguished engineers, Messrs. Clark, Stansfeld & Co. The *Atti del Collegio degl' Ingegneri ed Architetti*, published at Naples, describes another system introduced by Cavaliere Ercole Lauria, an Italian engineer.

This system of floating dock may be broadly described as divisible into two parts, the movable and the fixed. The former consists of a pontoon somewhat larger than the ship intended to be borne by it, and of a height proportionate to the weight of the ship. This pontoon may be of oak or iron, and is sunk by the introduction of water; and when emptied is capable of floating beneath the superincumbent weight of the ship. The so-called fixed part consists of a kind of dock, of a length somewhat greater than that of the pontoon, and generally sufficiently large to receive it. When it is desired to dock a ship, the pontoon is anchored in the open water outside the dock, such water having, of course, a sufficient depth to enable the pontoons, when sunk, to pass under the keel of the ship. From the end of the dock-wall nearest to the pontoon are extended india-rubber tubes in connection with the latter, by means of which tubes water or compressed air, as the case may require, can be pumped into the pontoon. In order to procure the level of the pontoon there may be fitted, if desired, certain guides or stays, but these do not form indispensable features of the design. On the upper surface of the pontoon are arranged parallel beams of iron which project considerably over the sides of the pontoon. The cradle for the ship rests upon these beams. When the pontoon is sunk the ship is towed into the cradle. A small portion of the water is then forced out of the pontoon; the pontoon then rises and adapts the supports to the ship. This accomplished, the floating of the pontoon is proceeded with until the ends of the beams float a little higher than the level of certain masonry ledges constructed along the parallel sides of the dock. The pontoon is then floated into the dock, and when in position is resunk, so that the beams carrying the cradle and ship ultimately come to rest upon the ledges of the dock walls, and the pontoon may then be towed away to serve for the docking of another ship. When the necessary work is done, the pontoon is re-introduced into the dock beneath the beams, floated by forcing out the water, and the ship thereby carried out to the open water, where the pontoon may be re-sunk and the ship liberated. For the dock walls, may, if preferred, be substituted two rows of piles, strengthened by horizontal ties and fitted with the necessary ledges. This will be found an economical and easy mode of construction.

The interior of the pontoon is divided into twelve compartments, provided with, in all, twenty-four india-rubber tubes, twelve tubes being used for the water supply and twelve for the air. The air and water are discharged from the pontoon by valves placed in its upper surface. The water, of which there should be a sufficient head, is pumped by means of a steam engine into a reservoir placed about three metres above the sea level. The air is compressed in another reservoir to a pressure of three atmospheres.

The calculated dimensions for an iron pontoon to be used in docking ships of a thousand tons and under are as follows:—Length, 75 metres; breadth, 18 metres; height, 2 metres; the weight of the pontoon proper being 276,000 kilogrammes. The volume of water necessary for sinking such a pontoon below the ship would be 2700 cubic metres. The volume of air which would be required to drive out the water and float a ship would be 1622 cubic metres. When the ship is floated, about 0·80 metre of the pontoon would be above the water. About twenty-three beams would be required, and in order that they may be sufficiently strong, they should be constructed of iron plates so as to constitute in section a rectangular tube of one metre in height. The time necessary for docking a ship would be about six hours.

ON A NEW PROCESS FOR THE ELECTRICAL DEPOSITION OF METALS, AND FOR CONSTRUCTING METAL-COVERED GLASS SPECULÆ.

PROFESSOR A. W. WRIGHT, of Yale College, published in the early part of the present year an account of a method of producing metallic films upon the inner surface of exhausted glass tubes by the action of a succession of energetic electrical discharges. The thickness of these films could be varied from a tenuity such that the coating barely gave indications of a metallic lustre, and scarcely dimmed the intensity of transmitted light, to the point where perfect opacity was attained, by simply continuing the action of the current for a shorter or longer time. They were produced by forming the regular electrode of the metal to be deposited, exhausting the tube, and passing through it the current from an induction coil. The metallic coatings thus obtained, as seen from the exterior, were very brilliant, but the condition of the inner surface was not readily observed, and the nature of the process made it seem probable that they possessed a dull or even a frosted surface. With a view to obtain the films in a form better suited for examination, a modification of the apparatus was contrived, by which they could be deposited upon pieces of plain glass. At first this was attained by inserting narrow slips of glass into the tube by the side of the electrode, in the manner suggested, with good results. But, as the nearer position of the plate received a larger share of the metal, the thickness of the deposit was not uniform, and it was found necessary to con-

struct a special apparatus, in which the relative positions of the plate and the electrode could be varied, so as to give the latter an equal action upon all parts of the surface to be covered. The plan employed was as follows :—A rather thick-walled glass globe, about seven centimetres in diameter, blown upon the rod of a tube twenty-five centimetres long and fifty-five millimetres in diameter, was used to form the receiver. The top of the globe opposite the tube was cut off so as to form an opening forty millimetres in diameter, and the edge ground flat, in a plane perpendicular to the axis of the tube. The end of the latter was drawn somewhat smaller in a gas flame, and a glass stop-cock attached to it with cement. A little way above this, a platinum wire was fixed into the glass to serve as the positive electrode. The cover of the vessel was made by cutting from a similar globe a portion corresponding in size to the part removed, but with the neck attached,—the two pieces being carefully ground so as to fix closely. When they were placed together, a little cement applied to the outside along the line of jointure rendered the joint perfectly air-tight. The tube or neck of the cover was five centimetres long, and was also somewhat reduced at the extremity by drawing it smaller. Into this was connected a small and thick-walled tube extending to a point near the centre of the globe. A platinum wire was placed in this tube, and fixed in at the top, enough being left projecting to form a small loop for the attachment of the wire from the coil. The inner end of the wire terminated at about one centimetre from the lower end of the glass tube. Into the latter was slipped a wire of the metal to be deposited, which, in all cases, was the negative electrode,—the part within the tube being long enough to make good contact with the platinum wire, and being bent somewhat so as to cause it to retain its place by friction. In some of the experiments a different cover was used, made from a glass funnel, the neck of which was left somewhat longer to afford more room for the swinging electrode, as described below, and the tube carrying the latter was fitted into the top by grinding, so as to make an air-tight joint.

For the support of the plate, a small watch-glass, about three centimetres in diameter, was employed, to one edge of which a thread of glass was fixed by a blow-pipe flame, and then bent so as to form a loop by which it could be suspended, like the pan of a balance. A small hook of glass was also attached to the side of the thick tube carrying the electrode, and upon this the pan was hung, the loop being so formed as to allow it to swing freely in all directions. The pan, when in place, was about fifteen millimetres below the end of the tube from which the electrode projected, the latter being adjusted to the proper distance by sliding it up and down in its support, as occasion required. By slightly inclining the globe the extremity of the wire could be readily brought over any point of the plate. In some of the experiments the plate was stationary, being held in a little tripod of glass threads, or simply laid upon the bottom of the globe. In these cases the tube holding the electrode was jointed near the top, the two portions being connected by a hook or loop of platinum or magnesium wire. It could be thus made to traverse all parts of the plate by giving suitable movements to the globe.

When adjusted and closed, the receiver was attached to the Sprengel pump. By means of a small air-pump of the ordinary construction connected with this by a stop-cock and flexible tube, the whole apparatus was exhausted as far as possible, and then dry hydrogen admitted, this being repeated two or three times in order to remove the air and moisture. The process of exhaustion was then completed with the mercury pump. The degree of rarefaction required varied somewhat with the metal to be deposited, but was rarely above 2.5 millimetres. For platinum the best results were obtained when it was from 1.5 to 1.75 millimetres. The use of hydrogen is not in all cases necessary, as some of the metals can be deposited perfectly well with only air in the receiver. This is especially the case with gold, but platinum, although ordinarily not easily combined with oxygen, becomes tarnished with a film of what apparently is the blue oxide, unless the air is removed. The electrode itself was formed of a small wire, usually not more than one-fourth of a millimetre in thickness, bent at the end into a circle three or four millimetres in diameter, the plane of which was perpendicular to the straight portion of the wire entering the glass tube, and parallel with the surface of the glass-plate situate beneath it. Its distance from the latter is generally about three millimetres, though considerable variations were possible. When it is farther away the process of deposition goes on much more slowly, though the results are in most cases quite as good as when it is nearer. After the process of exhaustion was completed, the stop-cock was closed, and the apparatus removed from the pump for greater convenience of manipulation in applying the current.

The electrical apparatus employed consisted of an induction coil capable of giving sparks four or five centimetres in length, and a battery of which the power could be varied according to circumstances. It consisted usually of pint Grove cells, from three to six in number, not completely filled up, or charged with rather weak acid, and a plunge battery of five cells, of which one, two, or more were used as occasion required, the whole being joined in a continuous circuit. By inverting the plates of the plunge battery more or less, as well as by varying the number in the circuit, the strength of the current could readily be changed within the limits desired. The various metals required currents of different strength, and the power best suited to each had to be determined by trial. It was found advisable in most cases to regulate it so that the temperature of the electrode was below that of a red heat, or such as barely to redden it. Of course with the more fusible metals it was necessarily much lower than this. The metal is actuallized by the discharge, as is shown by the fact that the characteristic lines of its spectrum may be seen with a spectroscope, and the film is formed by the condensation of its vapour upon the cooler glass surface. For the production of films with brilliant surfaces, the strength of the current must not be great enough to give the discharge a disruptive character, as this separates some of the metal in the form of powder.

The primary object of the experiments was to obtain films of the different metals upon thin pieces of flat glass for the purpose of investigating some of their optical characters. The apparatus appeared to be perfectly successful in its operation, and beautiful films of gold, silver, platinum, and bismuth, were obtained with ease and certainty. As has been mentioned, it seemed probable that the surface of deposit would be dull, but the first trial showed that this anticipation was incorrect, and the films, when removed from the receivers, exhibited surfaces of exquisite perfection and the most brilliant polish. They can only be compared to the surface of clean liquid mercury, far surpassing anything that can be obtained by the ordinary methods of polishing.

This circumstance suggested at once a valuable application of the process in the production of speculæ for optical purposes, and the subsequent investigations were directed to this end. The mirrors first made had been formed upon discs of thin glass, such as are commonly used as covers for microscopical objects, those being selected which were most free from defects, and had the best surfaces. By means of a very delicate assay balance, the weight of the glass discs, both before and after receiving the deposit, could be obtained to the one hundreth part of a milligramme, and hence it was easy to calculate the thickness of the metallic layer in any instance. By this means the relative transparency of the different metals can be determined, and the relation between the amount of light transmitted, and the thickness of metal traversed by it. The more particular consideration of these, and some other matters of interest as bearing upon the optical characteristics of the metals, are deferred : it is only necessary to mention here the results of some measurements made to determine the limiting thickness of a film in regard to the transmission of light ; that is, the thickness of a film that allowed only an inconsiderable portion of the incident rays to pass through. As the metallic lustre is developed gradually with the increasing amount of metal, proving that light actually penetrates these substances to a certain depth, it was important to ascertain whether the thickness of the layer, sufficient for the virtually complete reflection of light, was enough to affect perceptibly the figure of a glass mirror on which it was laid down.

Experiments were therefore made with gold and platinum, and the process of decomposition was continued until the films seemed to have just reached complete opacity. On their removal from the receiver, however, it was found in both cases that only a very small amount of light was still transmitted, as, on holding them to the eye, a brilliant object like the sun, or a bright flame, could be seen through them. The thickness of the gold layer was found to be 0·000183 mm., that of the platinum 0·000174 mm., or about one-fourth the length of a wave of light at the red end of the spectrum. The gold, although thicker than the platinum, transmits perceptibly more light, showing that to be the more transparent of the two metals. As the films employed for mirrors may be much thinner than the amount mentioned without any appreciable diminution of the intensity of reflected light, it is evident that the figure of a perfectly wrought glass mirror will not be changed when the metal is uniformly deposited to such an extent as to interfere with its favourable performance. A platinum film of one-fifth the thickness of the one described forms a brilliant mirror, transmitting but a very small percentage of light. The perfect control of the process obtained by the use of the moveable electrode will make it possible to apply the method of local correction for the improvement of a defective figure, or to parabolise a

spherical mirror by depositing the metal in a layer, increasing in thickness toward the centre, though, of course, it would be better to avoid a somewhat tedious operation by securing the perfect form of the glass beforehand.

Of the metals that are suitable for the formation of speculæ, platinum appears to be the most valuable. For while, when well polished, it is but little inferior to silver in reflecting power, and freedom from colour, it does not become tarnished by oxidation or the action of sulphurous gases; and when dulled by atmospheric deposits the surface can be cleaned by washing with water or with acids, which is an important advantage. By the method here described it can be deposited upon glass surfaces very easily, and a mirror of most perfect surface be produced at once without requiring any touch after. Several such have been made during these experiments by using concave glass lenses, and with most satisfactory results. The metal film adheres strongly to the glass, and when of sufficient thickness appears to be very firm and hard. In mirrors, silvered by the ordinary method, trouble is often experienced from the insinuation of moisture between the glass and the metal, resulting finally in the separation of the latter. In those prepared by the new process the adherence of the film is so close as to render that effect impossible. As a test of this, a small silvered speculum was placed in a beaker of water, where it remained for two weeks, and besides, this was wetted and dried repeatedly without showing the slightest tendency to suffer the penetration of the moisture. Similar results were also obtained with platinum and gold films.

With silver the process also succeeds well, but it is more difficult to obtain good surfaces than with gold and platinum. The metal is volatilised with extreme ease by the action of the current, and the energy of the discharges must not be too great. Of several trials made with this metal, the most successful was one in which, not only the degree of exhaustion of the receiver was less than had been employed in other cases, being only to three millimetres, but the electrode was more distant from the plates, and the battery weaker. The action proceeded slowly in this instance, but with the result of producing an excellent film. With a stronger current the deposit is rapidly made, and has a fine lustre, but the surface has a yellowish colour. This is perhaps partially due to a slight degree of oxidation, but also appears to be owing in part to the deposition of a portion of the metal in the form of fine powder, the vapour of the silver, as it streams from the electrode towards the most distant portions of the plate, becoming partially condensed, and falling on it in minute particles. That such a result would follow from this cause was shown by some of the experiments in which a rather strong battery was employed. The whole interior surface of the globe was in a short time covered with the powdered metal, appearing an intense purple where thinnest, and shading gradually to deep blue where thickest, the colour being the same by both transmitted and reflected light. The metallic lustre was wanting, though it was readily developed when a portion of the powdery coating, which was easily removed, was rubbed against the surface of the glass with some pressure. The defect was to a considerable extent remedied by surrounding the electrode with a small glass tube projecting some three millimetres beyond it, so as to clear the surface of the plate by an interval of one or two millimetres only. This cut off the lateral portion of the discharge, and confined its action to a limited area immediately below the extremity of the wire.

The yellow tarnish is removed with the greatest ease by gently rubbing the surface with soft chamois leather and a little rouge; and the metal is so hard that when this operation is performed with care the polish is not at all or very slighted affected. Even then, however, the metal is not perfectly white; it still has a very faint yellow tinge. It is well known that silver is not a perfectly white metal, for light which has undergone repeated reflections from polished surfaces of this metal, appears yellow or reddish-yellow, though this colour is not perceptible when the light has undergone but a single reflection. The real cause of this yellowish tint may possibly be found in the very tenuity of the films, which, when prepared in this way, have a beautiful and intense blue colour by transmitted light. When not too thick the amount of blue rays which they suffer to pass may be sufficient to cause by their abstraction a perceptible tinge of yellow, the complimentary colour, in the reflected rays. If this were really the case the colouration should grow weaker with an increase of thickness, and disappear when opacity is reached. Some of the results obtained seem to favour this view, and the probability of its correctness is strengthened by the facts that transpired, but further experiments are necessary.

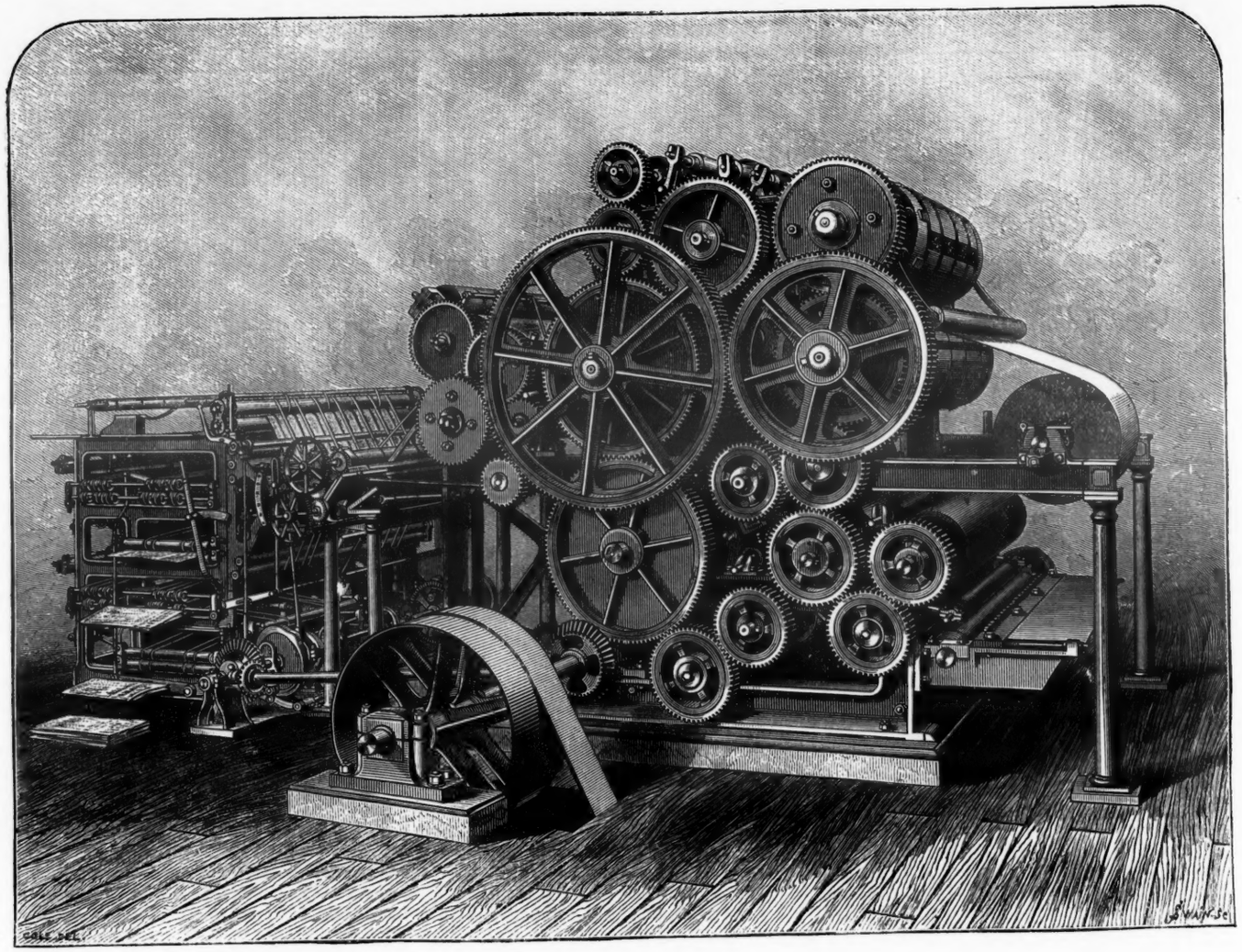
One result of this investigation has been to show that the colour of the light which has passed through a layer of metal varies somewhat with the thickness of the film. This was known to be the case with gold: experiment shows it to be true of platinum and bismuth. The latter in a very thin film appears a bluish-gray; a thicker film appears brownish. Platinum in a thin layer has a grayish tint, which varies, as the film is made thicker, to a peculiar brownish shade, somewhat like silica, passing into brownish-yellow, and finally becoming deep yellow, and inclining to orange in the thickest films. This colour is almost exactly complimentary to that transmitted by silver, and the possibility suggested itself of making a mirror which should be perfectly white by reflected light, by depositing first a thin stratum of silver, and over this another of platinum, the relative thickness of the two being properly regulated by observing the colour of the transmitted light. An experiment made with a circular disc of flat glass was perfectly successful, the platinum being readily deposited upon the silver, the yellowish tint of which it entirely removed, producing a white and brilliant reflecting surface. By transmitted light the film, as anticipated, has a pure neutral tint, with no perceptible colour of any kind.

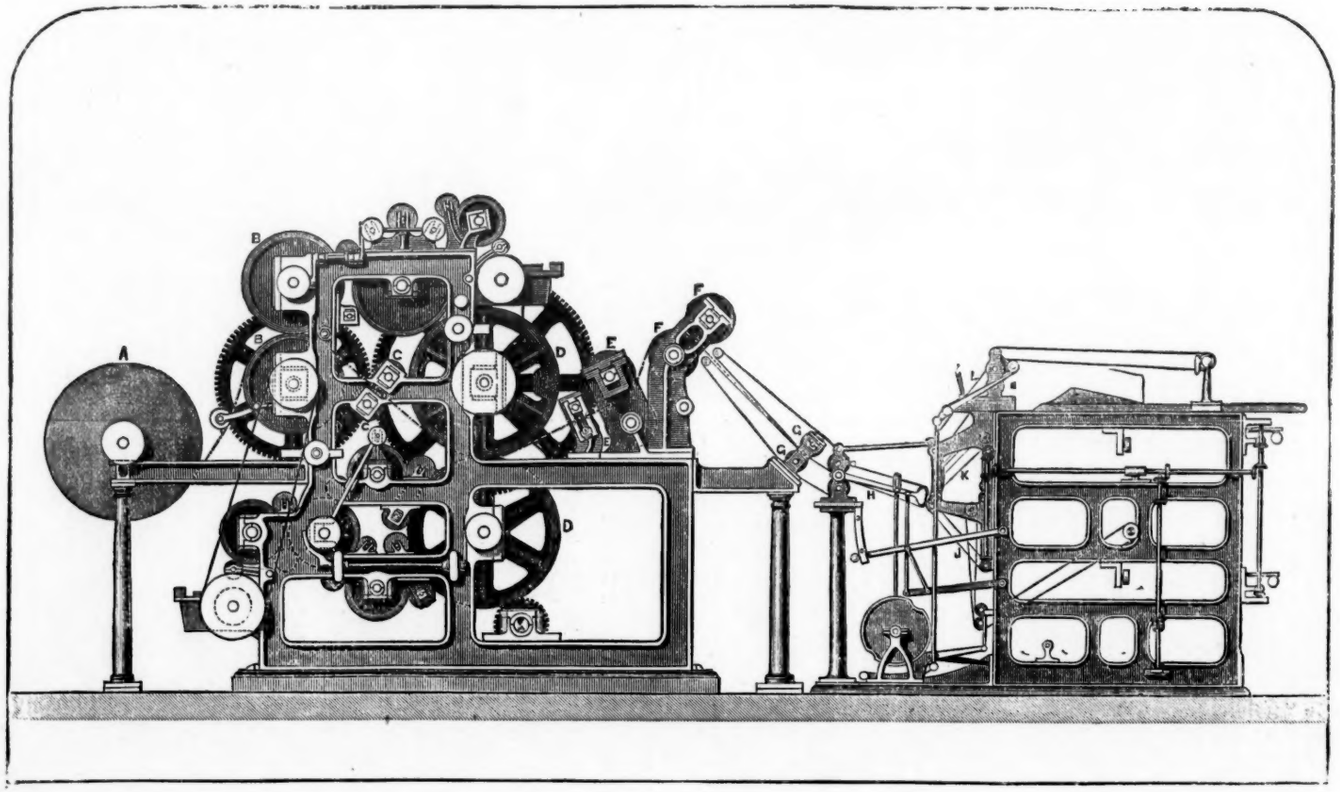
The value of such a combination for speculæ is evident, for although till careful measurements are made, it cannot be asserted that the absolute reflecting power is increased, the whiteness of the layer, and the protection afforded by having the surface covered with an unalterable metal are very substantial advantages. In constructing large mirrors, it will probably also be found to result in a material saving of time, the silver being so much more rapidly and easily deposited than the platinum. The process can also be used with great advantage for the construction of the solar eye-pieces for telescopes; since the compound film can be deposited directly upon the surface of the lens, and made thick enough to reduce the intensity of the light as much as desired. An image, nearly or quite colourless, could thus be obtained, and the disturbance of the rays should be less than that produced by the interposition of a dark glass of the ordinary kind.

As has been said, experiments were made with bismuth, and mirrors of excellent surface obtained, but the metal is inferior in brilliancy to platinum, and has a decided colour. The great facility with which films are obtained with it recommend its use for mirrors in some cases, but for most other purposes other results are to be preferred. Attempts to produce mirrors of iron and nickel were but partly successful; it was difficult to prevent tarnishing by oxidation. Some good iron films were obtained which were very brilliant; they were exceedingly hard, and adhered to the glass with such tenacity, that it seemed at first they had been fused into it, but when the film was dissolved off by an acid, the glass was found not to have been acted upon at all. A singular characteristic of iron in this condition is its chemical inertness; films prepared more than six months ago and freely exposed to the air, which, for a part of the time, was excessively charged with moisture, have not shown the least alteration. Nitric acid, placed upon one of them for a short time, produced scarcely any effect, and nitro-hydrochloric acid acted upon it with about the same readiness as it does upon platinum. This may be due to the extreme thinness of the film, in consequence of which even the exterior atoms of the iron, being within the rays of the molecular action of the glass, are held by a force tending to oppose and neutralize the attraction of re-agents that ordinarily attack the metal energetically.

It is not at all necessary that the object upon which the metal is deposited should be of non-conducting material. This is shown by the fact, that the process continues to go on after the glass has become covered with a perfectly continuous layer of metal of considerable thickness. The success of the experiment of covering a silvered glass with platinum is additional evidence of the same fact. In order more fully to test the question, whether a deposit could be made upon a solid piece of metal, a small silver coin was placed in the pan under an electrode of gold. It was covered in a few minutes with a beautiful coating of the latter metal, which was found to be very hard and perfectly adherent, possessing also, in every respect, its proper colour and lustre. At the beginning of the process, while still thin enough to allow light reflected from the silver to pass, it had a greenish colour, producing a curious effect.

As an example of the applicability of the process to practical purposes, it may be of interest to mention the results of some experiments in the construction of a small Gregorian telescope, the speculæ of which were covered with platinum by the method described, with entire success. The larger mirror has a diameter of a little less than four centimetres, and both this and the smaller one, so far as the nature of the surface is concerned, appears absolutely faultless. As only common lenses were employed in its construction, the performance of the instrument is not remarkable, but it is sufficiently good to warrant the assurance that the method will be serviceable for the production of speculæ of requisite quality for optical purposes. The size of the apparatus, which, for the convenience of experimenting was necessarily small, did not permit the introduction of larger mirrors, but

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there seems no reason to doubt that much larger speculæ can be successfully made in this way. The amount of time required for obtaining the platinum covering of this mirror was about three hours, during which the coil was kept in continuous action with a battery power equivalent to four or five small Grove cells. Mirrors of larger size would of course require a longer time, but with suitable apparatus, a much stronger battery and larger coil could be used, which would materially accelerate the operation. A plate two centimetres in diameter can be covered with platinum in twenty or thirty minutes sufficiently thick to form a good speculum. For gold or silver, the time would not be more than from ten to fifteen minutes.

Many useful applications of this process may be found, and its use is not limited to the metals which have been mentioned here. Moreover, for many of them, no other available process is known by which they can be deposited in a uniform layer and with a brilliant reflecting surface upon glass. A very thin layer of platinum, or, still better, of silver and platinum together, could be used with great advantage in the *camera lucida* and similiar instruments. Very perfect mirrors for galvanometer needles, and for delicate torsion apparatus, can be expeditiously formed in this way; and by the use of very thin glass, or the most delicate films of mica, they may be made of almost inappreciable weight. For the mirrors of heliostats, and other reflecting instruments in which a metallic surface is necessary, the speculæ produced by this method will be specially valuable. For telescopes, the beautiful process of Liebig and Foucault, for forming silvered glass speculæ, is recommended for the ease with which it is applied and the rapidity of its operation. But the perishable nature of the delicate silver film, and the difficulty of securing a firm and permanent adherence, are serious disadvantages. These are entirely avoided by the use of an unalterable metal like platinum; and though for instruments of the larger size the process here described may be found impracticable, for those of moderate dimensions there is every reason for believing it may be employed with complete success. The labour and time required for its application are indeed drawbacks; but there is compensation for this in the important circumstance, that the mirror comes out of the receiver with a surface of inimitable perfection, which would, in fact, only be injured by any of the ordinary methods of polishing.

THE END OF THE CAXTON SHOW.

WILLIAM J. INGRAM and his father have done as much in the development of the printing art for public advantages as ever did either William Caxton or John Walter, and one can never take a generation into review without seeing the very principles, which in the gloom of distance are superb, are really working among us. Why should not, then, the affection and admiration we willingly give to antiquity be bestowed upon our neighbours and friends? Our own lives have seen the perfections supposed to be, and the steps by which they have been, reached; but the story of printing machines is so great and so long that we had better begin at the end, and we will promise a good narration. Pages 236, 237 contain two views, wonderful to future generations. Look at them, and we will describe the machinery.

We illustrate above a new machine, which has been specially designed for printing the *Illustrated London News*. It has been invented by Mr. W. J. Ingram, M.P., who argued that, as type is printed from circular forms, engravings could be dealt with in the same way. The machine has been patented, and we cannot better describe the machine than by reproducing the following passage from Mr. Ingram's specification:—"It has been found in practice that cuts or engravings require much more careful inking than the letterpress, and that the ordinary inking arrangements, which are found to answer very well for printing letterpress, will give but very imperfect work from engravings or cuts. It has also been well-nigh impossible to obtain satisfactory impressions from cuts or engraved plates bent to the sharp curve required to correspond to printing cylinders of the ordinary size. In order to overcome these difficulties, I considerably increased the diameter of the printing cylinder to which the cuts or engraved plates are to be adapted, so that the curves to which these cuts or engraved plates are bent may be gentler and of longer radius than the curved surface of the other printing cylinder. By this means I am also enabled to place on the same cylinder two, three, or more copies of the cuts or engravings, so that while the surface speed of the large and small printing cylinders is the same, the small cylinder, if it contains only one set of stereotype plates for the letterpress, will rotate two, three, or more times for every revolution of the large cylinder. The impression cylinder, which acts in conjunction with the large printing cylinder, is also correspondingly increased in size, and rotates at the same surface speed. If desired, the type cylinder may be increased in size, so as to be capable of receiving a duplicate set of stereotype plates for the letterpress, while the large cylinder will have a triplicate or other suitable number of sets of cuts for the engravings. The large printing cylinders will therefore perform two-thirds of a revolution while the smaller or type cylinder is making one complete revolution. My next improvement relates to the inking apparatus, which is used in conjunction with the large printing cylinder, and consists in the use of an increased number of inking rollers and distributing rollers, so that the engravings may be more perfectly inked than heretofore. The ink, as is usual, is transferred by a vibrating roller and a ductor or fountain roller to the first distributing cylinder, from which it is taken by two rollers, and is deposited on a second distributing cylinder, to which an endway motion is given by means of any suitable mechanism. The ink is thereby evenly distributed over the surface of the second cylinder, from which it is transferred by other rollers to two other distributing rollers, in contact with which four inking rollers rotate and take therefrom the ink, which they transfer to the printing surface. In this manner the cuts or engravings are plentifully and evenly supplied with ink, and good impressions are obtained therefrom."

In our engraving A is the roll of paper, containing a length of about two or three miles. B the type and impression cylinder for printing the inner forme, or type side of the paper. C C calendering or smoothing rolls to remove the indentations produced by the impression of B, so that a smooth surface is preserved to receive the outer forme, or illustrated side of the paper, which is printed by D D. E E are cylinders, one provided with a saw-toothed knife, and the other with a corresponding indentation, to perforate the paper between each impression. F F are rolls for holding the paper securely, to resist the effect of G G, which are called snatching rolls, and being driven at a rather higher surface speed than the holding rolls, snatch or break the paper at the places where it has been perforated, and form it into separate sheets. As it is found that machinery for folding newspapers works much better at a moderate speed, in this case it has been arranged in duplicate, so that each folder only works at half the speed of the printing machine. The vibrating arm H delivers the sheets alternately to K and J, which are carrying tapes leading to the two folding machines. If the sheets are wanted unfolded, the arm H is moved to its highest position and there fixed; it then delivers the sheets to another roller, and by means of a blast of air and a flier they are laid in a pile on a table provided for them. This change can be made without stopping the machine.

It was to Mr. James Bristow, manager of the machine department of the *Illustrated London News* for the past seventeen years, that Mr. Ingram entrusted the carrying out of his design. Working from his plans, Messrs. Middleton & Co., of Southwark, finished the machine in little more than two years, whereas, we believe, previous improvements in rotary machines had not been accomplished in less than five years. The machine prints and folds 6,500 copies per hour. The second week it was in use for printing a large issue its average work exceeded that of four of the fastest "two-feeders"—a rapidity which may be realised all the more forcibly when we add that, whereas the new machine printed both sides of the paper, cut each sheet, and delivered it folded, the old machines simply printed one forme in the same time, and did not fold the sheets. There was thus a considerable saving of manual labour, only four men being engaged on the rotary machine, whilst twenty-four men were engaged on the four machines. Let it be added that the "Ingram" machine only occupies the space of an ordinary perfecting machine, and little more needs to be said to prove that it bids fair to effect as great a revolution in the printing of illustrated newspapers as the latest Walter and Hoe rotary machines have effected in the printing of daily newspapers.

It would not be candid to withhold honour to several of the objects lent to the Caxton Show; and in noticing this machine of Mr. Ingram's we must be understood as using it to illustrate the progress of the art even after all opportunity of exhibiting that particular production at South Kensington had passed away. The public is familiar with the Walter and with other of the immediate predecessors, between whom there does not appear to exist any jealousy. We gave an illustration of Mr. Hoe's wonderful invention some months ago in an article upon this subject.

But it is not only in presses that modern science has done well. There is no part of the furniture of a printing-office that does not witness to the service of the machinist and engineer. From being the simplest it has become one of the most illustri-

ous of specimens of modern scientific construction. Look, as an instance, at that marvel of ingenuity, Dr. Mackie's Steam-driven Type-setting Machines (Fig. 1) which have been in use eight years, and at the *Times* office in Printing House Square, London. The inventor is now building a place at Crewe for the production of these machines, and he is obliged to make it fifty yards in length. These have been improved until they seem to be perfect. Steam is used, but any other driving power would do. When steam is used, a boy can drive it, and can set 8000 letters in an hour, which is at least three times more than a skilled workman would undertake. The types are set in long lines in a kind of composing-stick, but removed at the end of every long line to the workman, who "justifies" it—that is, divides into the page lines, and equalises the spacing for the purpose of making the

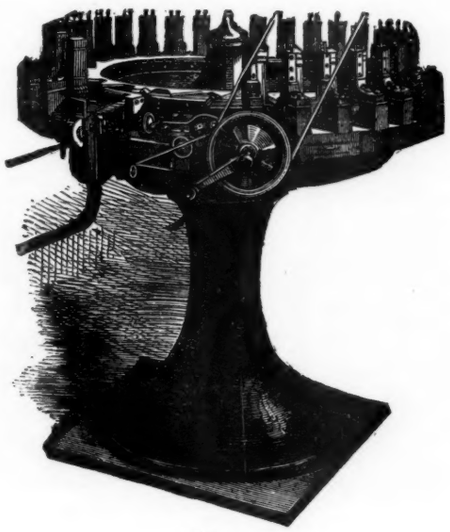
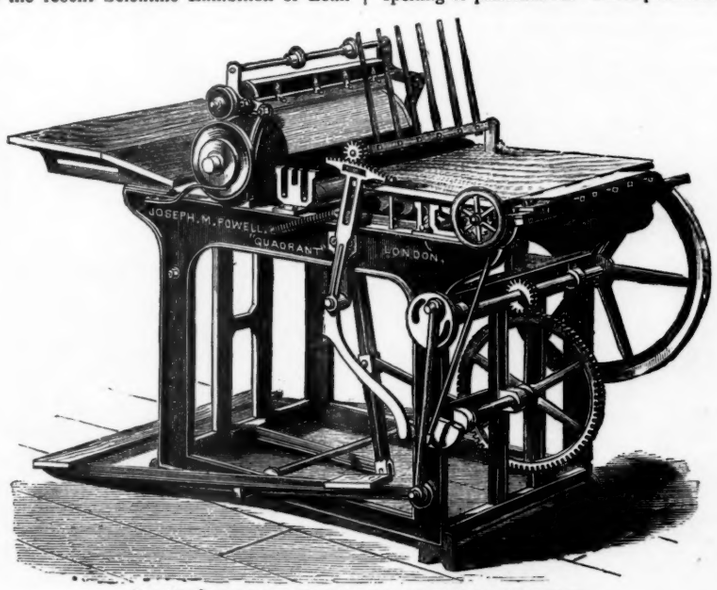


Fig. 1.
DR. MACKIE'S TYPE-SETTING MACHINE.

Fig. 2.
POWELL'S GALLEY PRESS.

lines even at the end. The process reminds one of that used in the Lyons riband trade known as Jacquard's, of which machines several were lent to the recent Scientific Exhibition of Loan Apparatus. Perforated paper is employed, and all the qualification of the controller is that he should not blunder either in spelling or punctuation. These perforations have to be arranged



POWELL'S QUADRANT CYLINDER TREADLE MACHINE.

or formed according to the size of the type to be employed, and will last a long time. The principle is automatical, and the motion rotary; nothing could be better adapted to the work in hand, and nothing is more successful. The tremendous demand for printed matter in England that shall be produced in the smallest conceivable time has caused the production of this and other machinery, some of which have been illustrated in former volumes. But the demand for labour does not diminish in the

least. In truth, it continually increases. Never, in the history of the trade, has there been anything approaching the present total of numbers engaged in connection therewith; and there is no prospect of any diminution resulting from the increase of these and kindred aids to labour, provided the men will keep pace with their times in general intelligence and in practical knowledge. A good compositor, machine-man, or pressman, is a fortune to himself and also to his employer.

Types have been the chronologers as much as machines have been; and how they have come to be of a certain height—and it is unmistakably certain now—is what no student of typography ever could understand. Why should an inch and a trifle be the standard height, when ¼ of an inch would have done, so far as surface is concerned? and why did that little accommodative half length totally fail, until it sank to pedlar vulgarity? The thumb of the receiving hand and the fingers of the giving hand made the length of an inch indispensable, when speed and observation combined to expedite labour. And, which is still the more striking, when there is a machine like the Clowes' Type Composing Machine, or even that venerable one of Young's in 1840, of which so much has been said that it is not desirable to say more than that the invention consisted of a set of elevated chambers containing types, which are pushed out of the said chambers, in the order required, by levers, acted on by keys touched by fingers and thumbs, and when pushed out of their respective chambers the types fall upon an inclined plane, grooved, and set up so steep an incline that the type slides down a groove leading to a small box, which is the "composing-stick," into which it drops. These pushers recover by a spring. These, and some details, make up the tale of that invention in 1840, on which Mr. Young made many improvements in 1858 and 1860.

Mr. Powell, of the *Printer's Register*, has been a very useful aid in making the Caxton celebration successful. It would, of course, be his business so to do, in one sense; but there have been contributions from him that added to the general success, which should be recognised. The New Web Galley Press (Fig. 2), which is worked by the Clowes' Type Composing Machine Hooker's patent, is to practical printers in magazine and journal labour a most useful aid. Two hundred and fifty words in fifteen minutes is not a bad pace for a compositor. It is from five to six stickfuls, and that means something over an hour. His Cylinder Treadle Jobbing Machine (Fig. 3)—so called from its applicability to general printing, where steam has not been possible or necessary—is another useful assistance, to country printers especially. It works, by the aid of two boys, at the average rate of not less than 1000 an hour, and without "slurring." There are some of them very small, say folio foolscap (half sheet), and occupy hardly any room. The fittings will take two colours in inking, and all necessary inking moulds and blankets; besides which it has cylindrical flier for taking the sheets, and delivering them with the printed side upwards, at the rate of 500 without stoppage. It is a cheap method of applying the principle familiar to all who know the more costly machines. Technically it is called "The Quadrant."

At the Caxton celebration, one admirer, whose name we have not obtained, but whose initials are T. J., put in evidence that movable types are not of European origin by distributing specimens of a publication dating in the tenth century, and issued by the Chinese. Marco Polo's authority is corroborative of his statements.

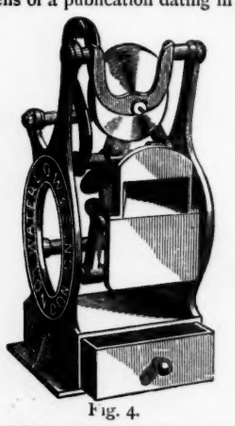


Fig. 4.
SKELETON RIBBON DATING PRESS.

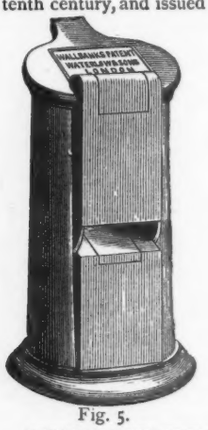


Fig. 5.
RIBBON DATING PRESS.

In machines, the curious little Passenger Ticket Printing Machines, now in use in most of the railway station offices of the United Kingdom, and indeed everywhere, are of the most modern of inventions belonging to the art. In great variety, striped in parti or double colours, numbered once or twice, perforated or plain, return or single, their variety is now astonishing, and they are produced complete from about a shilling a thousand.

These need a brief description. Dating Presses explain their purpose by their designation. Of the varieties these four are illustrated. The first (Fig. 4) works independently, and was the early machine. It is used now in small stations. The 2nd (Fig. 5) is on the ribbon system, which, we think, came to the printing art in card printing, from America, some forty or fifty years ago.

Then we have two, called Indenting Dating Presses, the one plain and simple (Fig. 6), the other Pillar (Fig. 7.) Three other

Fig. 6.
INDENTING DATING PRESS.

Fig. 7.
PILLAR INDENTING DATING PRESS.

machines of this house claim our notice. Fig. 8 is the Railway Passengers' Ticket Printing Machine. The plain tickets are inserted in the right-hand tube, pass along the plate and rise into the other tube in numerical order.

When the machine is driven from a shaft, the printer has simply to insert the bundles of plain tickets in one tube, taking the printed ones out on the other side, the machine stopping of its own accord and ringing a bell when any derangement arises from an imperfect card or other cause.

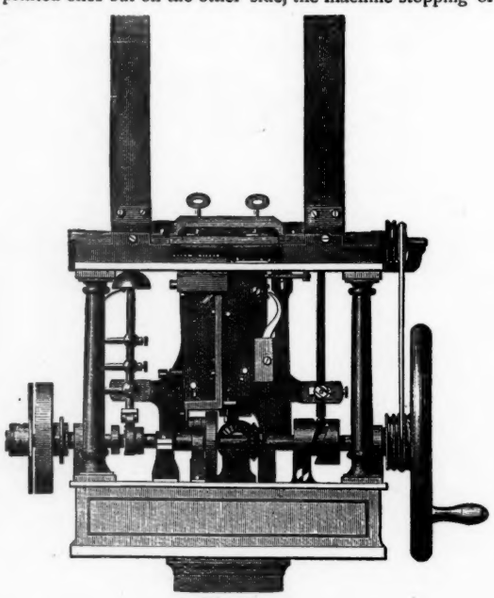


Fig. 8.
RAILWAY PASSENGER PRINTING MACHINE.

From this we have a Counting Machine (Fig. 9.) These are made in the most careful manner, and used to check the tickets after they have passed through the printing machine, to prevent

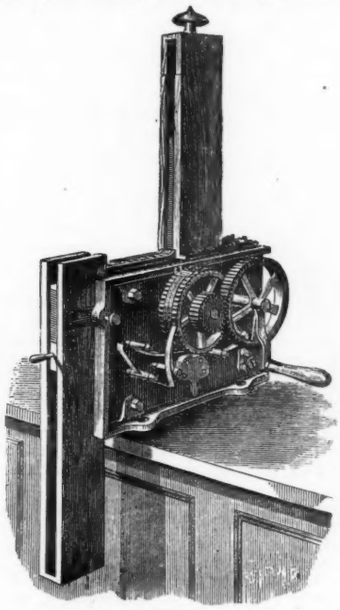


Fig. 9.
TICKET COUNTING MACHINE.

the possibility of any duplicate or imperfect ticket leaving the printing office. They count accurately at the rate of 10,000 an hour.

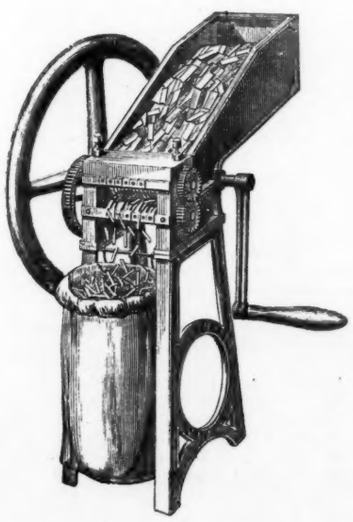


Fig. 10.
THE TICKET-DESTROYING MACHINE.

And lastly, there is the end of all things in Fig. 10—most essential in a Ticket printing office, to prevent the possibility of the tickets being used a second time.

We would gladly continue these descriptions if the space allowed. Enough is shown to prove that while engineering is winning its triumphs among the stubborn forces of nature, it can find a beautiful and excellent occupation in serving the ordinary purposes of commerce, and in the dissemination of wisdom and knowledge.

THE OBELISK CALLED CLEOPATRA'S NEEDLE.

WHEN the project for acquiring this historic monument came before the public in a practical form some months ago, we gave such an account as ancient history can supply of its changes and condition. It is now coming to London ; and all of us hope it will arrive in safety. The launch was an event of exceeding interest to all engaged in practical mechanics, for the apparatus had to be created, as no previous example of such a transference has been known in a manner that received the permanent form of an official communication. We are indebted to a contemporary for an excellent description of the methods adopted to put the unwieldy thing on board a raft, from the ditch where it had been lying for ages, and where it was partly buried through the lapse of time. Thousands of feet of earth had to be cleared to make a rolling path for the monolith, and a sea-wall to be demolished, before the other operations could be commenced. This consumed weeks ; but in the meanwhile the materials for the iron cylinders (such is the proper description), weighing over 60 tons, arrived, and were rapidly fitted together under Mr. Dixon, a civil engineer who had received government contracts for jetties and lighthouses and who had also performed many investigations among the pyramids and other antiquities of Egypt.

Stout backs of timber had to be introduced beneath the stone, which then could be moved bodily round until it lay parallel to the water's edge, when the iron casing, 3-8ths 7-16ths of an inch thick, was built up bit by bit around it and riveted together. This occupied two more months, at the end of which time the monument was completely enclosed in a cylindrical box 92 feet in length and 15 feet in diameter ; while these operations were proceeding, divers removed the block of stone that covered the shallow water bottom adjacent to the shore, and two sloping causeways were constructed of stone and quarry rubbish, down which to roll the cylinder. When these works were accomplished, there still remained one thing more to be done before the preparations could be said to be complete. It had been foreseen that in moving such a mass down the incline a certain amount of friction. which might materially injure the metal casing, was inevitable, To obviate this, a coating of wood planking had to be temporarily fitted upon the portions of the cylinder which would rest upon the causeway and have to carry the weight of the structure, and this coating again, had to be externally fastened by flat bands of iron to tie it in its place. The last stage of the preparation was reached when the strong wire ropes to be used in towing were passed nine times round the cylinder, and the end let out to lighters moored to seaward. On these last were fixed crab winches to heave in on hawsers, and thus cause the cylinder to roll slowly on its axis. At the same time, it was desirable to guard against the tendency of the mass when once set in motion to make too rapid a descent, and other hawsers had to be provided on the land side with which to check the movement if necessary. The 28th August, the day fixed for commencing the launch, began rather inauspiciously with what is very unusual at this time of year, viz., a thick fog. As the day wore on, however, this disappeared and gave place to the most intense heat. Before six o'clock in the morning the winches on board the lighters were at work taking in the slack of the hawsers, whilst, on the land side, four powerful screw jacks were being plied against the cylinder. A few yards to seaward two steam tugs were anchored, also ready to lend assistance if required. In a few minutes the huge mass of iron began to roll towards the sea, but so gradually that the movement was all but imperceptible. Hour after hour was thus spent, the cylinders lessening little by little the space between it and the water, till at noon it had made one entire revolution, equal to about 50 ft. Notwithstanding the sun which sent the mercury in the thermometer up to 90 degrees in the shade, the work went on uninterruptedly throughout the day and excited much interest, not only among the European population, but also amongst the Arabs, who crowded every spot from which a view of the operations was obtainable. Working the hawsers from the lighters had soon to be abandoned, as experience showed that, owing to the bad holding ground, anchors of the latter invariably came home when any great strain was thrown upon them, and the hawsers instead were led to the two tugs which, steaming full speed ahead, communicated to the obelisk just sufficient impetus to keep it in motion. At 5.30 p.m. the iron monster had been laboriously brought to the water's edge, where the wooden launching ways terminated, and a comparatively steep decline commenced. Here the cylinder went off with something like a rush, and took the water with a run of about 12ft.,

amidst the shouts of bystanders. After this its progress was as gradual as before, and the screw-jacks had to be kept in constant operation till shortly before 7 p.m., when it again made a sudden half turn, and rested for the night in 3ft. of water. This concluded the first day of the launch, and although some disappointment was felt that the obelisk was not yet afloat, the way in which everything had worked, and the absence of accidents, always excepting the parting of a hawser now and then, was satisfactory in the extreme. Soon after daylight on the 29th the proceedings were renewed, and a little before noon the cylinder made another rush and got so for out into the sea as to give rise to the impression that it was actually afloat. This, however, proved not to be the case, and during the whole afternoon the steam tugs remained towing away as before, the result being that at sunset on the second day of the launch the obelisk rested in 7ft. of water.

On the morning of the 30th work was resumed as before, but, unfortunately a difficulty of a somewhat formidable character presented itself, inasmuch as the cylinder was found to be nearly full of water. What made it worse was that as it happened to have stopped with what was properly the upper half submerged, it was impossible to open the man-hole doors to examine the cause of the leakage. In this emergency Arab divers were employed to examine the submerged portion of the casing, but although the water was singularly clear, they could not succeed in finding the leak. A hole was then to be cut in the upper part of the cylinder, and pumping commenced. Soon huge streams of water were seen pouring from the 15in. double barrel pump set going, and it was hoped that the cylinder would soon be cleared. When, however, after three relays of sixteen men each had been at work, and it was found that the water was in no way reduced, it was evident that there was a serious hole somewhere. A regular diver, in proper diving dress, was then sent down, and from his report it appears that a stone hidden in the sand had penetrated the bottom near one of the ends of the cylinder, and so caused the mischief. The removal of the stone, which was found to be firmly wedged into the opening, was the next thing to be done, and two more days were thus occupied. When the stone was at length taken out, efforts were made to roll the cylinder over sufficiently to raise the injured portion out of the water. This was effected by means of a powerful hydraulic jack, worked under water against the cylinder, aided by hawsers led to the lighters to seaward as before. Even with these appliances the mass moved but slowly, and it was not till noon on the 5th September that the damaged plate appeared above the water's edge. The next operation was to fix a fresh plate over the hole, which was found to measure 18in. across, and this was finished on the same day. Next morning two pumps were set to work to clear the cylinder of water, which was accomplished about sunset. On the 7th the movement of the cylinder recommenced, the tugs steamed ahead, and bit by bit it moved into deep water, the work becoming easier as the mass approached the depth of 9 ft., at which it was estimated to float. Shortly before eleven in the forenoon the final move was made, when the cylinder after making a portion of a turn more rapidly than before, was observed to rise and fall with the swell coming in from the Mediterranean, showing unmistakeably that it was at last afloat. Shortly after, the wooden casing was stripped off, and, amid cheers from the crowds that lined the shore, the strange craft was towed away to the new harbour. Here the railway iron, which had been placed in the upper part of the cylinder to counterbalance the weight of the needle was taken out, and the iron vessel, which had hitherto floated on its side, at once righted, and appeared in something like sea-going trim. When fairly in the water, the cylinder, which floats with a displacement of 280 tons, draws 8 ft. forward and 10 ft. aft, and presents as remarkable an appearance as, perhaps, any marine structure afloat. Want of symmetry, however, is, in this instance, more than compensated for by strength and utility, and there can be no reasonable doubt that this ungainly craft will, with an ordinary amount of luck, suffice to convey her interesting cargo to Engand in safety.

PHILLIPS' TRAMWAY CAR MOTOR AND BRAKE.

BRAKES are absorbing the attention of engineers and inventors more and more, and will continue to be the centre of much anxiety and the subject of careful thought for a long time yet. It is an outcome of modern locomotion rendered necessary from the tremendous impetus given to vehicles driven by steam or upon rails, and although much has been effected and hundreds of experiments made, and inventions patented, the problems involved are not yet satisfactorily demonstrated, or the results definitely assured. On the railway brake we published a most valuable document a few months ago, from the pen of Colonel Tyler, and now we notice an invention designed for a like office upon vehicles running over tramways.

From practical experience it is found that it takes five horses to start a car as easily as it takes two to keep it in motion when started, and that, therefore, if only two horses are employed, they have to put forth the ordinary strength of five before a yard of this journey is covered. More expense, wear and tear, and risk of accidents comes from this loss of power than can be estimated. We might say that it abridges the existence of the horse's life more than one half, and necessitates the proprietor to double his stock in order to avoid further ruin by over-fatigue. A system that can employ eighty cars needs an equipment of a thousand horses, and that demands corn, stabling, and labour, more than double the positive result ought to cost and an enormous waste of capital.

All the brakes, as yet devised, are worthless when put into comparison with this invention of Mr. Phillips. They are worthless of themselves, and every one has been a failure; deceiving when most trusted, and powerless in times of dire emergency. It consists of a self-contained mechanism for stopping and for starting the car, and, of course, is especially useful in regulating and breaking the impetus. This is effected by what may be termed a reservoir of power, derived from an arrangement of springs. The entire apparatus is built up in a frame and carried on the axles; the frame taking all the strains of the machinery for stopping and starting, and also the check employed to brake.

We will describe the mechanism. When the driver wishes to stop the carriage he lays hold of a lever connected with a conical friction-clutch, which, by mechanical contrivances, governs a rack of compressing or spiral springs, in fact, forcing these spiral springs into a shorter than abnormal length, thereby storing up power for the time of restarting the vehicle. When that time comes, the driver has only to relieve the before-mentioned lever and the compressed springs expand to their original position, utilize the power that has been, so to speak, stored up, through the alterative gearing on the axle, and the vehicle is propelled sufficiently for to make a start, thereby relieving the horses of that double work above-mentioned, which is the great strain in again setting in motion the dead load.

But there will often arise emergencies demanding the instantaneous employment of sufficient force, to abruptly and suddenly bring the moving object to a stand-still. This exigency is provided for by the addition of another lever connected with straps that encircle the peripheries of the conical castings.

These straps being drawn tight, act with braking power upon each pair of wheels, but in a manner perfectly independent of either. The strain of this braking power is toward the centre of the axle, and the strain of the braking rods is upon the frame enclosing the mechanism, and as has been stated, quite independent of the bottom framing of the car, being neither connected with or attached thereto. Thus is obviated, or rather avoided, the unpleasant, and dangerous, and destructive action, known by the term "hogging," and also preserving from strain and destruction the mortices of the framing appertaining to the car, and as a consequence of much value, preserving the rolling-stock from disastrous wear-and-tear. The horses are saved the irregular and highly injurious extra and sudden effort, and the vehicle an injurious stain.

Any one will perceive, from this statement, the advantages that are here conferred. The company or proprietors of a tramway enterprise are spared the outlay of half their capital in horse-flesh; their carriages will continue much longer in good working order, the protecting machinery is independent of the carriage, and can be repaired, or the car repaired without any injury to either, and in fact, is superior in its results to the ordinary brake, or buffer-stop, used on railways. The action is simple and easy. It is merely the hauling to of a lever, quite contrary to the wheel employed in the brake-van, wherein five times more labour and strength are required, and then at a large expenditure of time and great and dangerous effort. There is no noise; the passengers do not hear, feel, or see anything; it is not likely to fail or slip, and can be regulated absolutely at pleasure.

We have thus said enough to commend an invention that will by-and-by have a much wider utility than it now seems to possess, and claims most justly.

HOUSEHOLD FURNITURE AND INTERNAL DECORATION.

THE past will yield wisdom to those who desire instruction ; the present is rich in experience to those who are active : the future invites hope to those who have both endeavoured faithfully to learn and honestly to labour. Aphorisms like these are peculiarly appropriate to the case of those who are studying the subjects named on the title of this brief paper. The past is their lesson-book ; they will do right only so far as they recognise and appreciate the excellencies that are to be gleaned from among the relics and lumber of forgotten time. They can no more be original than they can make a new alphabet, and create a new and universal language : they must take the old language. They are at liberty, while imbibing the grace and power of Spenser in his "Fairy Queen," to decline adopting his mode of spelling, but they are not able to supersede the spirit. They may describe matters well, but are not quite free to substitute an imitation of Chaucer's English, but they will not better his power of description. Many ape these things and fail. No ! The past is "written for our instruction :" we must adopt that past to the present requirements if we desire to be useful and good. A nation that is perpetually changing its rulers or form of government will most surely soon have no ruler and no order. Therefore in offering a view of the past ideas on Household Furniture and Decorations as an illustration of the necessity of the above remarks, we are confident of the sympathy of those who, being free from vanity and conceit, and seeking the comfort of those whom they love in connection with their improvement in taste, desire above many things to be guided into those paths of true culture which not only gratify in the time present, but provide material not to be discarded by the second or the third generation.

We have known, and who has not, the household goods around which tender associations clung, scattered to the winds because they really did not represent the intelligent choice of the intelligent parent, although they were the companions of childhood, and the patronized acquaintances of the incipient man. This ought not to be. The furniture, like the pictures, in a man's home, should represent *him*. His books do, and why not the chair or his private rooms. It is not cost that is necessary : it is good form. The stock of the sea is as finely represented in the little sea-horse of the Mediterranean, as in the royal sturgeon, or the magnificent gambols of the whale ; and a man can have his book-shelves testify to his love of truth quite as strongly as the burden they contain : so of his chairs, his tables, his chimney-pieces, and all the belongings. It is not cost, nor is it style, it is *Choice*. The man says "I like that" : from that moment he is therein portrayed. Wife will give way, but most likely she will like it all the better. Children will grow up in a reverence for associations not purchased at trumpery upholstering stores, or derived from the ruins of mankind, but made at father's choice,—because he liked it ; and it conformed to his means, and his best culture. These, although not hundreds of pounds left in a will, are more likely to be coveted than any other store.

Household furniture "comprises an infinite variety of different productions of human industry, wrought in wood, in stone, in metal, in composition of various descriptions, in silk, in wool, in cotton, and in other less usual materials. *Each* of these different articles is capable of uniting to the more essential requisites of utility and comfort for which it is most immediately framed, and with which it can consequently on no account dispense, a certain number of secondary attributes of elegance and beauty, which, without impeding the chief purpose of the object, may enable its shape and accessories to afford additional gratification, both to the eye and the mind."

These various articles in former days, abandoned even in this country almost entirely to the taste of the upholsterer who did not pretend to, and did not possess any knowledge of, the most common principles of visual beauty, and wholly uninstructed in the simplest rudiments of drawing except in so far as a few wretched and trivial conceits were concerned, and those were borrowed from the degraded French school of a hundred years ago, are totally destitute of those attributes of true elegance and beauty, which, although secondary, are of great importance in the enlargement of the area of rational pleasure. We have made great advances during the last fifty years, for then furniture of every description, wrought by the most mechanical processes only, either remained absolutely void of all ornament whatever, or if made to exhibit any attempt at embellishment offered in its decoration no approach towards that breadth and repose of surface, that distinctness and contrast of outline, that apposition of plain and enriched parts, that harmony and significance of accessories, and that apt accord between the peculiar meaning of each imitatve or significant detail, and the peculiar destination of the main object to which these accessories belonged, and which are calculated to give the eye and mind the liveliest, most permanent, and most unfading enjoyment. The article became more expensive without becoming more beautiful. Such remained, the which, by being employed in the formation and purchase of furniture objects of lasting perfection and beauty might have increased in endless progress the opulence of the individual, and the wealth of the community.

So it happened that he who, desiring to decorate his dwelling in harmony with his own taste, could not find dealers or makers, and was driven abroad to buy his furniture ; and then after great expense, he perhaps only obtained the remnants of stock which he imported to the discouragement of English artists, the benefit of foreign traders, and the acknowledgment of the degradation of English taste : at the same time the purchaser had not realized his own ideal.

Intelligent and wealthy persons desired to unite in this matter the style of ancient art productions with modern handicraft, in the hope that the invasion upon existing folly would produce some contribution of elegant style into their dwellings. The monotony oppressed them. It was tiresome and insignificant both in form and ornament, and a better example became at once indispensable and inevitable. Thus insensibly arose the culture of design in every variety of application that could be adapted to the comfort of man, whereby followed a beneficial influence which in its diffusion broke down the barriers created by the monopoly of artificers. The plodding weary repetition had to give way to the claim of the draughtsman, modeller, the painter, and the sculptor.

Machinery had begun to perpetuate certain modes and forms. The handy man whose skill had inspired poets and seers by the wonder of his carving and the life he infused into the materials of nature, began mournfully to find his occupation gone, and a dead uniformity of technical poverty usurping his authority. The mind he loved to exercise and to gain his bread thereby, seemed likely to be of little avail in the defence and provision necessary to his calling and his home. Genius, that friend of the isolated, could scarcely be loved, and, where recognised, difficult to worship as it should be worshipped, being God's precious gift to man, had no chance in the upstarting worship of machinery. It was necessary to vindicate the claim of the craft*sman*, for the *man* surely was more than his craft, and there were men who sought to entice the wealthy into the old paths by encouraging the producers of original works that should be artistically adapted to the circumstances, shapes, aspects, surroundings, and tastes of individuals. These in their lofty aims sought to "give new food to the industry of the poor, but a new and more excellent direction to the expenditure of the rich, thereby increasing the well-being and trade of the nation; but improving the culture and happiness of the individual."

These views prevailed after long waiting, but the difficulties must be recognised. Try to unite various modifications of visible and intellectual beauty with the necessities of utility and comfort in an age of hard, dead formalism that had not a shadow of beauty or usefulness except in a distorted and uncomfortable form. No man like Crace, Graham, Gillow, and others were to be found. Nothing ennobling could be included in the possibilities. You could not obtain a table, a chair, a footstool, or a screen, with shape and accessories that cost nothing but thought, for any money you might offer.

So the gentleman takes to drawing his own designs ; and down goes the upholsterer. He learned to draw in order to amuse his leisure ; but he is obliged to draw because his tradesmen do not know their business, or because they attempt to impose a stereotype form on what he is resolved shall be a reflection of his own mind, and part of his outward representation among his friends and visitors. The gentleman became his own draughtsman, and to that he was soon compelled to become a modeller ; for the art of modelling had gone to the sepulchre which shrouded the truth of form. Details, of themselves a worldful, had to be exhumed chiefly from the imitation of the ancients ; and domestic architecture—by which we mean all objects, forms, and ornaments proper to a dwelling, had to be a new creation. Italy had to be ransacked ; Egypt to be studied ; Greece to be explored. Then came the carver and the caster. These were all asleep in the general atrophy, and it cost a man a wilderness of days to search out artificers worth possessing.

The public regarded the movement with more than common regard. It had suffered, and hailed deliverance. It had been blinded, and felt gratitude for new visual powers. It saw what

had been inflicted, and demanded a change. Then came forward architects, young upholsterers, cabinet makers, and others who, abandoning the beaten track, exhibited in design and in execution an approximation to the revival of lost ideas and the culture of the unknown novelties. These were of various merit. Some meretricious, others honest: but the bad seemed likely to perpetuate the evil they pretended to cure, by producing what was worse than its predecessor, its only claim being novelty.

That time has passed away, but the vices thereof are still existent. The young student is in the same peril as his ancestors, unless he take to the study of the old and the new, having regard to ancient habits, manners, and localities. The eye of the intelligent observer turns painfully away from almost all warehouses that sell furniture, and he must be a bold man who would give *carte blanche* to any one undertaking to decorate rooms in the style you are known to prefer.

Nature and Art must not be separated, any more than Religion and Politics.

SILVERSMITH'S WORK.

THE following communication of Mr. Frederick Ross to the *New York Tribune* contains information not frequently to be obtained :—The process of hammering out a piece is very long, and consequently expensive, so it is only used for pieces of great value. A more rapid and cheaper mode of manufacture is employed for such pieces as teapots, cream and ice-pitchers, &c. The first operation is to transform a "skillet," or ingot of silver, into a thin sheet of metal. This is done by rolling. When the skillet, weighing about 250 pounds, comes from the foundry, where it has been made by pouring melted silver into a skillet mould, it is about 1½ inch thick, 8 inches long, and 6 inches wide. It is then placed between heavy iron rollers; each roller is 3 feet long and from 10 to 12 inches in diameter. These rollers are horizontal, and the space left clear between them is regulated by screws, which, when turned, draw these large cylinders closer together. The moment the skillet is drawn in between the rollers it takes about 40-horse steam-power to make them revolve. This enormous force ceases to be required as soon as the silver comes out, but will be needed again, when, after a turn of the screws has brought the rollers closer, the silver is again passed through. This renders necessary great perfection of work in the governor of the steam engine, which must be capable of furnishing at any moment a large extra power which will be thrown off soon after without any alteration of the normal running speed. The skillet is drawn through the rollers repeatedly, and each time a turn of the screws, drawing them closer together, produces a corresponding diminution in the thickness of the silver. By repeated rollings, it is clear that the metal, which is very malleable, will diminish in thickness while it spreads in length and breadth—and at a given time it will come out from between the rollers as a thin sheet of metal.

The mechanical process, or "spinning," is the next stage through which the silver is passed to make, for instance, a teapot. A disc of metal of the required size is set upon a spinning lathe, is held in the centre between two pieces of wood, one of which is used only to hold the silver in position, while the other represents the shape the silver has to be made into; this piece is named a "chuck." The lathe is then started, and the silver disc revolves with great rapidity. A workman with a burnisher over two feet long including the wooden handle, operates upon the outer edge of the disc as it spins round, and using great pressure brings the end of the tool, which is in shape like a round steel knob, in contact with the metal. The length of the tool, one part of which rests upon a metallic bar—a part of the lathe, and technically termed a "rest"—gives the worker great leverage, and the silver disc, soon yielding to the pressure of the tool, is curved in, and the malleable metal is soon changed from the disc shape to that of a saucer and eventually to that of a bowl. The operation is continued until the metal is made to fit close, or to "hug" as it is technically named, the shape of the "chuck." This chuck, which is exactly of the shape to be assumed by the silver, is constructed in sections like a shoe-last, and by withdrawing the centre piece can be easily removed.

When the operation of spinning is concluded, we have, for instance, two pieces of silver which are intended to form the upper and lower parts of a teapot. These two pieces are taken to the silversmiths, who will unite them to make the body of the teapot. To do this he takes a long band of silver, on one side of which a decorative pattern has been stamped by passing it through steel rollers, on one of which is cut the pattern to be reproduced. The pressure of the rolling prints the design on the silver. This band of metal is shaped into a circle, forming as it were the "equator" of the teapot, and the two halves of the body are soldered to it. The spout, handle, and cover, are next placed in the proper position, and the piece passes to the finishers. The finisher first removes all the inequalities of the surface with pumice stone, and when the outside of the teapot is perfectly smooth it is placed on a polishing lathe. The brushes of the machine are circular, and revolve with great velocity—over 3000 turns a minute. They are made of a great number of thickness of Canton flannel, cut out with a circular punch and then strongly fastened together at the centre by wire clamps. Successive passages from one brush to another, the first one containing oil and rotten stone, the last covered with ordinary rouge, brings on the surface of the metal a smooth polish like that of a crystal mirror. In some cases a peculiar dull surface, called "satin finish" is thought more suitable to the aspect of the piece. It consists in slightly indenting the surface of the silver with blows struck by hard wire brushes worked by steam, which gives the metal the appearance of being covered with minute crystallisation. Different colours of gold and metallic oxides are often used to decorate the surface of silver. Electricity is of much service to the manufacturer in all these operations. Many pieces of hollow ware are decorated with chasing, engraving, and hammered work before they are polished. Silver waiters are hammered out on large flat anvils, and the particular curve round the edge is produced with a "swadge" hammer. The process of swadging is very frequently resorted to in manufacturing iron and tin ware, and consists in hammering the metal with one hammer, the face of which is cut like the profile of the curve to be given to the metal, which rests on a small anvil the same size as the hammer's head, and bearing the exact counterpart of the curve on the face of the hammer. The metal struck between these pieces of iron soon retains the form of the "swadge." Often an ornamented border of rolled silver is soldered on the edge of the ware, while the centre is decorated with engraving.

PASSENGER BOGIE CARS.

CARS having this quaint designation are to be adopted on the Midland Railway without delay, and as it is likely that that example will have a most serious influence on the whole of English locomotive policy and practice, it may be acceptable to give a brief description of the innovating vehicle. As the name implies, the introduction is ascribed to an American inventor; it is a name ill accordant to the genius of our language, and ill suited to our usages in conversation or public announcement: most probably it will be changed for something more appropriate. The principle of construction is essentially American, but the adaptation necessarily differs from that system. English habits do not, nor will they be likely to conform to those on the other side of the Atlantic, especially in the arrangements adopted for promiscuous intercourse among travellers.

The sample now completing for the South American Continent varies from the American models, and is mounted upon trucks having four wheels, with pivots more than 30 feet apart. The sides of the body frame are constructed girder-fashion, and the body is about 45 feet in length, but because of its having to be conveyed by sea, restrictions are imposed on the structural size that might have been detrimental. The engineer has as he believes, succeeded in attaining all the required strength, with the least possible quantity of material. This transport business caused much anxiety, in that the whole must be cut into four sections to be put on board; but by an ingenious method the full strength of the original design is preserved by fixing in their positions the upper and lower truss planks and the top girth, each of which is the full length of the body, and form parts of the girder. The tie rods pass through the three girths—top, bottom, and middle, and also through the supports of the principal frame, holding the whole together firmly, and binding at the same time. All these were easily separated and packed; and in order to make assurance sure, vertical trusses under the foundation rods were provided.

The roof rises in the centre like a kind of turret ship arrangement. There are glazed sashes properly hanged, which constitute the sides by being placed in a frame, which is in one piece from end to end. The very weak roof is strengthened by the use of seven wrought-iron rafters, reaching from side to side. These have tie rods connected with the frame binding, feet, roof, and side. Slanting timbers, characteristic of American engineer-

ing, make up the foundation frame; they look ugly, and they are liked. Dr. Wilberforce, the Bishop of Oxford, coined a word that is most expressive in mechanical science, as it was in theological. He styled some things "slantindicural." Slantindicuralism resists the force of concussions, and still more collisions. A collision is neutralised if there is a ghost of a slant.

Ventilation is the direst trouble in railway cars, as in rooms or public places. Human refuse is omnipotent: science cannot, it appears, clear away the ordure even of her children; or she will not. Try and ventilate your own private room, or if you have one, your reception room! As well ask any other impossibility; and yet the principles are at your command, and it is within your power to enforce their exercise. To ventilate these cars recourse has been had to the old plan of introducing air into the spaces between the windows at the top part of the sashes, in the frames; and, making two facia boards the whole length of the carriage, admitting freely the common air. When the air enters this double facia it comes into a cavity that descends to the middle sash, and through a wire gauze the air passes into the car. The method is elaborate, and includes needless delay; but it is successful. By this means an equal temperature and pleasant coolings are diffused, dust is excluded, and the miserable conditions are destroyed.

Cleminson's cars have their buffers in the very centre of the main frame at the bottom, as in the English cars, he thereby has repudiated the silly and mischievous effects of almost all the American vehicles, wherein the buffer is a kind of attachment that has no power or resistance, because it has been made an appendage, as if of superfluous or doubtful utility.

The form of buffer and draw-bar which Mr. Cleminson has designed in this case gives what may be called an equilibrium buffer and draw-bar, for whether the action be buffing or drawing, the resultant strain is distributed equally on the whole of the springs, and they are compressed to an equal degree on each side of the central block against which they bear, and in this way the frame is relieved of all shocks and sudden strains. The draw-bar at the outer end is composed of two pieces of angle-iron so disposed as to form a sleeve of a square section, within which the buffer rod slides, and at the outer end of the sleeve or draw-bar is fixed a peculiar shaped hook, to which is attached a chain, hook, and screw-coupling for the purpose of coupling the buffers up tight.

The bogie trucks are of the standard type in use in America with some slight modification—as will be seen in the form of the axle guards, which in this instance are made of flat wrought iron—and also in the manner of carrying the compensating beams which are attached to the bottom of the axle-boxes, instead of resting, as is usual, on the top of the same; this was done to gain space between the upper surface of the axle-boxes and the truck frame, in order to keep the buffers as low as possible. It will be observed that the trucks have swing bolsters, and possess all the refinements peculiar to American practice. The wheels are entirely of wrought iron, and have steel tires secured in their places without bolts, screws, or rivets. The brake is arranged so that it may be applied to both of the trucks from either end of the car; the brake blocks are made in two pieces, one being a permanent fixture on the beam, and receiving a shoe which takes all the wear, and which may be replaced when worn out without disturbing the other piece. The internal fittings are extremely elegant; the framing is of teak, selected with regard to beauty of grain, whilst the panels are of sycamore relieved with ebony mouldings, and picked out in gold. A lavatory is fitted at each end of the car at opposite corners, one being for the use of ladies, and the other for gentlemen, the doors of these enclosures are also furnished with mirrors, filling the whole of the upper panel; the sash lifts, door handles, and other furniture are of nickel and brightly burnished; they are also sunk flush with the frames, in order that no part shall project and interfere with the free circulation of the passengers. The lights in the sides of the upper roof are of coloured glass, cut with elegant devices. A netted brass wire rack for hand luggage runs the whole length of the car on each side over the windows, and is supported at intervals by brackets of neat form and finish. The windows are framed in mahogany, and are made to lift in opening. Handsome tapestry curtains or blinds carried on rollers, which are self-adjusting in any position, are fitted to the windows.

The seats are framed in teak, with light cast-iron arm rests, and legs of symmetrical outline. The backs are stuffed with horse-hair, and, like those in American cars, are reversible. The seat frames are caned for summer use, and loose cushions are fitted for use in winter; the cushions and backs are covered with superfine cloth of a tint harmonising with the surroundings, and the floor is covered with oil-cloth of pretty design and colours. The cars are lighted by clusters of lamps burning mineral oil, and carried in metal frames of extremely elegant design and finish. Altogether these cars reflect the greatest credit on the builders who have so faithfully carried out the designer's views. These cars have sixty seats, with an abundance of room for each passenger, not only in the seats themselves, but in the circulation space.

A number of second-class cars have also been built. They are identical with those under description, so far as proportions and details of construction are concerned; but the disposition of seats is, of course different, and the internal fittings are less costly. The seats in these latter cars are arranged parallel along the sides and down the middle, the passengers sitting with their backs to the sides of the structure. In this way accommodation is provided for ninety passengers.

THE DIRECT PROCESS IN THE PRODUCTION OF IRON AND STEEL.

IRON and Steel producers are under great obligations to a few men: obligations which can never be cancelled or rewarded. The name of C. W. Siemens, D.C.L., F.R.S., will be recognised as such. Of distinguished powers, he is devoted to the promotion of the interests of all who are connected with the department of knowledge he has made his specialty, and with a free hand dispenses all his acquisitions therein.

Processes are necessarily of the most serious consequence to the metallurgist. His expense is great: he may get upon the wrong track; he may allow his mind to become prejudiced in theory or in practice; and thus, while apparently working to advantage, ultimately become useless. Then again:—any one who has observed the history of scientific or mechanical progress, cannot evade the singular fact that it is perpetually necessary to revert to first principles—A man tries to build upon the acquisition or explorations of predecessors by taking for granted all belonging to their elevated positions; he finds by-and-by that he too, as they did, must go back to the beginning—ascertain the nature and laws of the material or form he desires to utilize; and, while grateful for the heritage derived from previous students, he must learn that such experience is more useful in teaching what is to be avoided, rather than a guiding power in his progress.

Dr. Siemens, in treating of this subject, is as usual intensely practical and candid: he gives the result of his own labour, before those labours have come to a conclusion:—

"In mixing comparatively rich iron ore in powder with about twenty-five per cent. of its weight of pounded coal, and in exposing this mixture for some hours to the heat of a common stove or of a smith's fire, metallic iron is formed, which, on being heated to the welding point, on the same smith's hearth, may be forged into a horse-shoe of excellent quality. The admixture with the ore of some fluxing materials, such as lime or clay, will, in most cases, be of advantage to rid the iron of adherent slag."

The simplicity of this process is such that it naturally preceded the elaborate processes now in use for the production of iron and steel upon a gigantic scale, nor can it surprise us to find that attempts have been made from time to time, down to the present day, to revert to the ancient and more simple method. It can be shown that iron produced by direct process is almost chemically pure, although the ores and reducing agent employed may have contained a considerable per centage of phosphorus, sulphur, and silicon; and that, if freed from its adherent slag, it furnishes a material superior in quality and commercial value to the ordinary iron of commerce.

The practical objections to the direct process as practised in former days, and as still used to a limited extent in the United States of America, and in some European countries, are that, in the first place, only very rich ores are applicable, and only half of these are converted into iron, the remainder being only slag. Secondly, Charcoal is the fuel, and three or four tons are required in producing a ton of hammered blooms. Thirdly, Labour; thirty-three men working twelve hours, can produce only one ton of metal.

Iron produced by direct process in the Catalan forge is therefore expensive iron that cannot compete with that produced by modern processes, except for such special uses as melting material for the tool-steel melter.

A question arises,—Why cannot the advantages of the direct process be combined with those modern appliances for the produc-

tion of pure and intense heats, and for dealing with materials in large masses, without the expenditure of manual labour; and why cannot chemistry find us larger yields and facilities for employing the poor and impure ores?

These questions led Dr. Siemens some years ago to the conclusion, that therein was a promising field for the experimental metallurgist; and that he possessed advantages in the use of his regenerative gas furnace, as a means of producing the desired heat, without using charcoal and blowing apparatus. In 1873, he engaged on a series of experimental researches at his sample steel works at Birmingham, which led to his well known paper on this subject. That experiment led to the larger applications of the principle tested, and to the creation of the Towcester Works.

The locality was not well chosen. Fuel, skilled labour, and good ores did not abound; but there was an ample supply of Northamptonshire ores at a low cost. This apparent advantage ceased to be of value; for while the ore was capable of producing iron of good quality, it was too poor and irregular in quality to yield profit unless mixed with an equal weight of rich ore, such as potter mine, Spanish ore, or roll-scale, all of which were greatly enhanced in price from the high rates of carriage prevailing there. These works will be removed.

They were visited last year, however, by Professor von Tunner of Leoben and A. Kerman of Sweden. Those reports were published, and have led Dr. Siemens to say sooner than he would what he has to say about the progress effected and the conclusions to be drawn from his experience:—

The leading idea which guided me in these was to operate upon such mixtures of ores, fluxes, and reducing agents, as would, under the influence of intense heat, resolve themselves forthwith into metallic iron and a fluid cinder, differing essentially from the methods pursued by Chenat, Guilt, Blair, and others, who prepare spongy metal in the first place by a slow process, which is condensed into malleable iron or steel by after-processes, but assimilating to some extent to the process first proposed by Mr. William Clay. In my paper of 1873, I described two methods of effecting my purpose—the one by means of a stationary, and the other by means of a rotative furnace chamber, the former being applicable chiefly where comparatively rich ores are available, and the latter for such poorer ores as occur near Towcester.

At the Towcester Works three rotative furnaces have been erected, two of them with working drums 7 ft. in diameter and 9 ft. in length, and the third of smaller dimensions. The gas flame both enters and passes away from the back end of the furnace, leaving the front end available for the furnace-door, which is stationary. The ends of the furnace-chamber are lined with Bauxite bricks, and the circumference with ferrous oxides, resulting from a mixture of furnace cinder enriched with roll-scale or calcined blackband in lumps. About 30 cwt. of ore, mixed with about 9 cwt. of small coal, having been charged into the furnace, it is made to rotate slowly for about two and a half hours, by which time the reduction of the metal should be completed, and a fluxed slag be formed of the earthy constituents, containing a considerable percentage of ferrous oxide. The slag having been tapped, the heat of the furnace and the speed of rotation are increased to facilitate the formation of balls, which are in due course taken and treated in the manner to be presently described.

These balls contain on an average 70 per cent. metallic iron, and 30 per cent. of cinder; and, upon careful analysis, it is found that the particles of iron, if entirely separated from the slag, are pure metal, although the slag may contain as much as six per cent. and more of phosphoric acid, and from one to two per cent. of sulphur. In shingling those balls in the usual manner the bulk of the cinder is removed, but a sufficient residue remains to impart to the fracture a dark appearance, without a sign of crystalline fracture. The metal shows, in being worked, what appears to be red shortness, but what should be termed slag shortness. In repiling and reheating this iron several times this defective appearance is gradually removed, and crystalline iron of great purity and toughness is produced. But a more ready mode of treatment was suggested by Mr. Samuel Lloyd, one of my co-directors in the Towcester Company, in reverting to the ancient refinery or charcoal hearth. The balls, as they came from the rotator, are placed under the shingling hammer, and beaten out into flat cakes not exceeding an inch in thickness. These are cut by shears into pieces of suitable size, and formed into blooms of about 2 cwt. each, which are consolidated under a shingling hammer and rolled into bars.

The bars have been sold in Staffordshire and Sheffield at prices varying from £7 to £9 per ton, being deemed equal to Swedish bar as regards toughness and purity.

It may therefore be asserted, as a matter of fact, that iron and steel of very high quality may be produced from ores not superior to Cleveland ores by direct process; but the question remains at what cost this conversion can be effected. The experimental works at Towcester are, unfortunately, not sufficiently complete to furnish more than the elements upon which the question of cost may be determined, the principal reasons being that the one reheating furnace and a 30 cwt. hammer at the works are not sufficient to deal with the iron produced by the three rotators, that the iron has to be finished at a rolling-mill elsewhere, and that transports weigh heavily upon the cost of production. The principal factor in the calculation of cost is unquestionably the rotator. The mixture of ore for each charge consisted of 12 cwt. of Towcester ore, containing about 38 per cent. of malleable iron, mixed with 8 cwt. of calcined Great Fenton ore, 1 cwt. of tap cinder, 1 cwt. of limestone, and 6½ cwt. of small coal. The time for each charge was four hours, and the yield of hammered blooms averaged 6 cwt. 2 qrs. 13 lbs.; whereas the metal in each charge was estimated at 9 cwt., showing a loss of 25 per cent. That loss was partially covered by reusing a portion of the cinder; but using that with impunity depended on the amount of such impurities as phosphorus, sulphur, and alumina contained in the ore. The coal used in the producers amounted to two tons per ton of hammered blooms produced; and in pricing the used materials and the labour, £380 had to be charged as the cost per ton of hammered blooms. Added to this, repairs, general expenses, cost of rolling into bars, working the metal in the hollow fires, which is 25s. to 30s. a-ton—making the refined iron £5 5s. to £5 10s. per ton.

In using hematites or other rich ores, it is better to employ a stationary furnace, and to modify the process thus:—

A mixture of pulverulent ore, mixed with a proper proportion of fluxing materials and reducing agents, is prepared, and four or five tons charged from a platform into the heated chamber to a depth of 12 or 15 in. Before charging the mixture coke dust or anthracite powder is spread over the bottom and sides of the chamber to protect the silica lining. The heat is then raised to the full welding point, taking care that the flame shall not be oxidising. The result is a powerful superficial action upon the mixture, or batch, causing simultaneous reduction of the ore, and the fusion of earthy constituents. In the course of two hours a thick skin of malleable iron is formed all over the surface of the mixture, which, on being withdrawn by means of hooks, is consolidated and cleared of cinder under a hammer, and rolled out in the same heat into rough sheets or bars, to be cut up and finished in the refinery furnace or charcoal hearth. One skin being removed, the furnace is closed again, and in the course of an hour and a half another skin is formed, which, in its turn, is removed and shingled; and so on, until, after three or four removals, the furnace charge is nearly exhausted. A fresh charge is then added, and the same operation continued. Once every twelve hours the furnace should, however, be cleared entirely, and the furnace lining be repaired all round.

The shingled metal so produced forms an excellent melting material for the open-hearth or Siemens-Martin process; but if ores both rich and free from sulphur and phosphorus are used, together with roll and hammer scale, which forms an admirable admixture, I simplify the process still further in causing the fusion to take place in the reducing furnace.

The furnace having been charged with, say, five tons of batch, the heat is allowed to play on it for four or five hours, when about two tons of hematite pig-iron are charged upon the surface by preference in a heated condition. The pig metal, on melting, constitutes a bath on the surface of the thick metallic skin previously formed, and gradually dissolves it on the surface while it is forming afresh below, and in the course of from three to four hours the whole of the materials charged are rendered fluid, consisting of a metallic bath with a small percentage of carbon, covered with a glassy slag containing about 15 per cent. only of metallic iron. The carbon of the bath is thereupon brought down to the desired point of only about 1 per cent. of carbon, and spiegeleisn or ferro-manganese is added, and the metal tapped in the usual manner. By these means the direct process of making cast steel is carried to a further limit than I have been able to accomplish before, and no difficulty has presented itself in carrying it into effect. The steel so produced is equal in quality to that produced by the open-hearth process as now practised. If light scrap, such as iron and steel turnings or shearings' are available, these may be mixed with advantage with the batch to increase the yield of metal.

JABLOCHKOFF'S GALVANIC BATTERIES.

MR. Jablochkoff has rendered another contribution to science in his patent of a new kind of galvanic cell, which he further protects by another on the generating motive power arising out of it. In the new battery the current is produced by the action of a solid body in a state of fusion upon carbon. Instead of taking metal for a negative electrode of a battery—that is, the electrode which is consumed in the action—Mr. Jablochkoff uses coke or an artificial conglomerate of carbonaceous matter possessing the same qualities, and acts on this electrode by means of nitrate of potash, of soda, or of ammonia, in a state of fusion. On account of its cheapness, nitrate of soda is preferred. The carbonaceous matter is acted upon by the molten nitrate in the same manner as zinc is acted upon by the different acids or salts in the ordinary batteries. As the second electrode, he places in the same liquid either platinum or other metals that are not acted upon by the liquid in the presence of carbon. The crucible itself, in which the nitrate is fused, may constitute the positive electrode. For introducing the carbon into the liquid, the former may have attached to it a metal rod, which serves as an attachment for the conducting wires; or a metal grating or perforated metallic receptacle may be placed in the liquid, in which the carbon is contained, such grating or receptacle being insulated from the crucible, if this constitutes the second electrode. In the latter arrangement, the carbon may be added from time to time, as in a furnace, in proportion as it is consumed.

For bringing the battery into action in the first instance, the nitrates may either be fused in advance in the crucible, and the carbon be then introduced, or the nitrate may be placed in the crucible in a pulverulent state, and the carbon be ignited and plunged into the nitrate. While the battery is in operation, large quantities of gases are evolved, similar in their nature to those produced by the combustion of gunpowder. These gases, collected by any suitable arrangement (as, for instance, in a boiler or closed chamber), may be utilised as a motive power, so that the improved battery serves as a source both of electricity and of motive power. By mixing various metallic salts with the nitrates, the double effect may be obtained of regulating the intensity of the action of the battery, and of obtaining metallic deposits upon the positive electrode, as in the ordinary electro-plating process. In one arrangement of the batteries, the crucible containing the nitrate and carbon forms the positive electrode, the carbon being suspended in the liquid nitrate in a wire-gauze cylinder attached to a cross-bar, the ends of which rest upon a ring of insulating material on the top of the crucible. The latter is closed in by a hinged cover, having an aperture, to which is connected a pipe for conveying the gases generated to wherever required. According to another arrangement the crucible is made of earthenware, glass, or other suitable non-metallic substance, centrally within which is placed the wire-gauze cylinder containing the carbon, and surrounding this a metal cylinder constituting the positive electrode, or this may simply consist of a rod or bar of metal. If it be desired to employ the battery principally or entirely for utilising the gases generated as motive power, as before described, the crucible or vessel containing the nitrate or carbon is closed at top, and is provided with a pipe leading to a boiler or closed vessel for collecting the gases under any desired pressure. The top or dome of the crucible may in this, as also in the previous arrangements, be provided with a hopper closed by a valve, through which fresh carbonaceous matter may be introduced from time to time, and also with a second hopper for the addition of nitrate when required.

The outer receptacle of the battery is of metal, and can itself constitute the positive electrode. The negative electrode consists of charcoal or coke contained in a wire-gauze cylinder, which is suspended by a frame on the top of the vessel, the frame being insulated by the introduction of insulating material. Outside the wire-gauze cylinder is the molten nitrate. In consequence of the large amount of gases evolved from the chemical action, the vessel is closed by a cover provided with a pipe led to a chimney. The cover opens on a hinge to facilitate the introducing of the charcoal into the cylinder. A cell is provided in which the casing is of earthenware, porcelain, or other non-metallic substance; centrally within it is the charcoal cylinder forming the negative pole. The positive pole can be attached to a metal rod passing down in the nitrate, or it may be supported by a cylinder split longitudinally like the zinc cylinder of a Bunsen's battery.

Mr. Jablochkoff's other apparatus is for collecting the gases evolved, and conveying them to any suitable motor engine. This apparatus could be used exclusively for producing gases to be used in motor engines—that is, the electric current produced need not be made use of.

Results are not yet ascertained either as to efficiency or economy.

THE DRAINAGE OF WHITTLESEA MERE.

A QUARTER of a century has elapsed since the Whittlesea Mere was drained by the first large centrifugal pump on Mr. Appold's system, erected by Messrs. Easton, Amos, and Sons, for Mr. W. Wells, owner of this extensive reclamation, which extends over 6600 acres. Mr. Wells witnessed the trials of a new and much more powerful pump and engine, erected by Messrs. Easton and Anderson. The history of Whittlesea Mere is peculiarly interesting, because the effect of draining has been to lower the land in a remarkable manner. At the time the first pump was inaugurated in 1852, a pile was driven into the mere close to the main road leading to the engine-house; it was cut off level with the surface of the land, and it may now be seen projecting at least 9ft. above it.

The effect of this subsidence has been gradually to increase the lift from 4ft. 6in. to nearly 11ft. The original pump, which was designed to raise 55 tons of water per minute, was placed so high that it ceased to act at 4ft. above datum. In 1860, eight years after its erection, it became necessary to add suction pipes, by means of which the drainage could be carried to 3ft. 8in. below datum, but it was found that although the pump, if once started and kept steadily going, would draw the water down the required depth, yet the fan being placed so high made the charging a matter of difficulty, so that in 1871 Mr. Wells had the pump lowered 5ft. 6in., and by that means obtained complete control of the drainage down to 2ft. 6in. below datum. It was now found that the increased amount of work to be done overpowered the steam engine, so that during the last two winters a good deal of land was flooded. Mr. Wells accordingly determined to put up entirely new machinery, and again sought the aid of the firm that he had originally employed. The old pump had a double inlet fan, 4ft. 6in. diameter, and 1ft. 1½in. wide, keyed on to a horizontal spindle actuated by a pinion, which was originally driven direct by the spur fly of the engine; but when the pump was lowered in 1871, an intermediate wheel had to be introduced. The engine was a compound beam, having the high-pressure cylinder 13½in. diameter, by 37½in. stroke, and the low-pressure, 23¾in. by 51in. stroke. The new drainage engine has a vertical spindle pump, arranged on the maker's latest patent, with single inlet, fixed balance disc, and guide curves to absorb the momentum of the water after it issues from the fan, which is 6ft. in diameter, and 1ft. 4in. deep. The pump is designed to lift 90 tons of water per minute to a maximum height of 11ft., and is placed so that it will draw to 5ft. 9in. below datum.

The steam engine is again a compound beam, the high-pressure cylinder 15in. diameter, 37½in. stroke, the low-pressure 25in. diameter, 54in. stroke, both steam jacketted all over and using steam at 60 lb. pressure. The small cylinder is fitted with double slides expansion motion, which can be varied as the engine runs. The governor is speeded to raise at five revolutions above the normal speed, so as to act only in case of the fan drawing air or any part of the gearing giving away. The pump is actuated by an annular internal spur fly-wheel gearing into a mortice pinion keyed on to a short horizontal shaft, which, by means of a pair of mitre wheels, drives the pump spindle.

In order to test the performance of the pump a weir 12ft. wide was fixed in the delivery channel close to the river in a situation very favourable to accurate observation. It was found that with 60 lb. steam pressure cutting off at three-fourths, expanding therefore about 6 to 1, and at 10ft. 2in. lift, that 88 tons of water per minute were delivered, the engine indicating 115-horse power. This is the first large pump of the new kind that Messrs. Easton and Anderson have erected, and it is somewhat remarkable that Mr. Wells should have been the first to adopt Mr. Appold's pump in 1852 and the present novel arrangement twenty-five years later. There can be no doubt that the new pump is of sufficient power not only to master any ordinary flood, but to do so without the necessity of working night and day.

THE UTILIZATION OF BLAST FURNACE SLAG.

SLAG has become one of the most attractive subjects for inventors to experiment upon and investigate. More than fifty patents have been taken out with the view of rendering it a commercial commodity, and very large expenditure of time and money has been made to the disappointment of nearly all who have placed confidence in the various really plausible schemes. There are now a dozen classes of goods into which slag is being manufactured and its use is extended in various ways. Mr. Wood of Middlesborough has devoted some years of attention to the subject and has put forth a paper, "On the progress of slag industries during the last four years." It partakes somewhat of the egotistic spirit, but the information is of great value. He had shown in 1873 how the proper preparation of slag could be employed, and at the end of four years returns to say that his previsions have been realized, and that the manufacture of slag into mortar, cement, building bricks, superior concrete which will set perfectly in water, is now being carried on at Middlesborough, even in these bad times, at a reasonable profit. At the Tees Ironworks, there are three slag sand machines and two slag shingle machines working, all of which are profitable. In order to test the value of the slag trade out of the 100,000 tons that had been treated, it was thought advisable to form a company that should take up the manufacture as a specialty, and thereby devote the necessary time and attention required for a new and untried manufacture. This company has been working for two and a half years, and has had a severe ordeal and many difficulties. Machine after machine broke down, and money, time, and patience were well nigh exhausted, but Mr. Wood found friends in Messrs. Gilkes, Wilson, Pease and Co., and friends in the company itself—neither time, money, or patience have been spent in vain, and sanguine hopes of a fair dividend are excited. Mr. Wood shall tell his own tale from this point :—

The Cleveland Slag Company's works are situated near the docks at Middlesborough, and are now paying between £60 and £70 per week in wages. The most important part of their manufacture is slag bricks for building purposes, made from the slag sand, produced by the slag sand machine at the blast furnaces. This sand is mixed with selenitic lime—General Scott's patent—with an addition of iron oxide, and is pressed in a machine hereafter to be described. The next article of importance manufactured at these works is a kind of hydraulic cement, made from the slag sand, common lime, and iron oxides. Compared with Portland cement for hydraulic work or concrete, this is the most valuable product introduced for many years, whilst its price is not one fourth, and the strength little inferior. Concrete made from this cement, mixed with the shingle produced from the rotary table, is an excellent conglomerate for use in monolithic structures. With this material I have executed some very heavy blast engine foundations—in one case where brickwork set in cement had previously failed. The concrete is now standing in the most perfect manner. The cost of the concrete is only about one-fourth that of the brickwork, and experience has shown that it goes on hardening for months. The building of the slag company's works is executed entirely in this material —the walls being nearly 80ft. high—they were built entirely by labourers, without a single bricklayer, and the cost of the work when finished, including superintendence, did not exceed six shillings per cubic yard. To give an idea of the strength of the walls, I may mention that on one or two occasions we have had to cut doorways through them, and it has taken two good men with steel bars and sledge hammers as much as four days to cut through a thickness of about 26in. Mortar is also made and sold in large quantities from a mixture of slag sand and above 10 per cent. of common slaked lime, and it can be sold at at the cheap rate of about 4s. per ton. The introduction of these various products from slag at first met with a good deal of opposition and prejudice from architects and builders, but the remarkable strength and cheapness of the material soon compelled these gentlemen to admit their error, and I am happy to say that our demand, in some instances, is now more than the production. As before stated, the most important branch of the business carried on by the Cleveland Slag Company is the manufacture of building bricks, and although the process is now very simple, it has been here that the greatest difficulties have occurred. There was no machine made in England that could work the material in the state in which it is produced at the furnaces without previous preparation ; and to prepare the material to suit the brick press, meant, that the cost of the bricks became so high as to exclude them from the market. A press had, therefore, to be designed that would work the slag sand just as it comes from the slag sand machines, directly into bricks; and this being accomplished, success was assured. In designing this machine, the following points had to be kept in view, viz., great depth of moulds, because the slag sand is very spongy and compressible ; an arrangement by which the water could escape from the moulds without blowing the bricks to pieces ; great pressure, in order to consolidate the sand in moulds ; safety against over-pressure, in case too much or too hard a material should get into the moulds ; and great care in mixing the lime with the slag sand in fixed proportions ; as well as great regularity in filling the moulds. These requirements are fully met by the brick press, which is, in my opinion, one of the safest and most powerful mechanical brick presses ever made. The bricks, when taken from the brick press, are placed upon spring barrows holding fifty each. They are then taken and stacked in sheds, where they are allowed to remain about five or six days, after which they are simply stacked outside in the weather to harden. The precentage of loss is very little, not amounting to 2 or 3 per cent. In fact, when once the bricks are upon the barrows there is little or no waste. Each machine is capable of turning out about 100,000 bricks per day, and we have sold about 4,000,000. Large quantities are shipped to London at a cost of 17s. to 18s. per 1000 for freight ; about 10,000 tons of slag sand have been consumed for this purpose alone. The following are a few of the advantages of these concrete slag sand bricks, viz. :—Being pressed, they are perfectly uniform in size and thickness ; they are much cheaper than ordinary red bricks, compared in weight, with which they will weigh one ton per thousand less, and there is this further advantage that there are no wasters or halves. For inside work there is a great saving both in bricklaying and mortar, more especially when plastering ; the walls being of a uniform thickness ; and the bricklayers like them, because they can do more work with less labour, the bricklayer's labourer finding he has a ton per thousand less to carry, as well as considerably less mortar ; another remarkable property of the slag bricks is that the joiners can drive nails directly into them without splitting, and thus for skirting and door work they are saved much trouble in plugging the walls, and, finally, the longer the bricks are kept the harder they get. I can now confidently say that for many months past we have been steadily working away at the various products mentioned, and that with the exception of a little outlay for the purpose of increasing our output, we have laid out no money upon experiments or works. The task, however, has been severe. In designing the mill, I had the assistance of some of the most experienced millwrights accustomed to machinery for manipulating hard and gritty substances ; and yet there is scarcely a piece of machinery on the works, with the exception of the engine and shafting, that has not either been abandoned, redesigned, or rebuilt, in order to adapt the machines to this peculiar material, the extraordinary cutting nature of which seemed to destroy everything with which it came in contact. In six hours' working, the fields and furrows in a pair of French burr mill stones, intended for Portland cement grinding, were completely obliterated, whilst the hardest steel bars in a Carr's disintegrator were cut completely through after six or eight days' constant running. The position of an engineer and an inventor under these circumstances is one which has to be experienced to be appreciated. In addition to the works and progress made by myself at the Tees Ironworks and the Cleveland Slag Working Company's works, I must not forget the labour and success obtained by my friend, Mr. Henry Hobson, engineer at the Moss Bay Ironworks, Cumberland. Mr Hobson has taken a path different, so far as I know, to any of his predecessors, inasmuch as in making bricks, he first of all pulverises the solid slag and uses no lime whatever. By this system the slag is taken from the solid slag balls, made from hematite Bessemer iron and broken into pieces sufficiently small to pass under very massive edge runners, where it is ground or crushed by the sheer weight of the runners into small dusty shingle. It is then passed by elevators into French burr mill-stones and ground into powder. From the stones it passes directly into the brick press without any admixture of lime or any other aid except that of being well damped with water before pressing. This brick press has also a rotary table, and the material is fed into the moulds recessed therein by hand. The pressure is given from above by a self-acting cam, put in action by the continuous rotary motion of the table, and the bricks come out well pressed, of excellent shape, and there appears to be no doubt about the quality. They have a great many wasters. The bricks are heavy and the cost of grinding the slag entails an expensive plant, with a large amount of wear and tear. The large quantity of lime in the slag made while producing Bessemer iron seems to be sufficient when treated in this way to re-unite the pulverised

slag and to "set" in a most remarkable manner. I suppose that the slag, when pulverised in the dry state in which it comes from the furnace, takes up a large amount of water, and forms a hydrated compound of silicate of lime and alumina, and thus reunites the mass in the same way as Portland or Roman cement. On the other hand, this excess of lime is dangerous, as the slag, after exposure to the air or an excess of moisture, often swells and pulverises, so that bricks made from it are liable to fall to pieces. This is not the case with Cleveland slag, nor, I think, with any, except with that made from hematite ore with an excess of lime. The next process in successful operation is that known as Woodward's, and most of their manufactured articles are of a very serviceable nature. They are, however, only employed for footpaths, roads, &c., being unfit for building purposes. As at present worked, the process is not at all complicated, but only certain qualities of slag are suitable, and at times when the furnaces are "changing" the number of wasters is enormous, while the works have sometimes to be stopped for days. The slag is run direct from the furnaces into moulds ranged around the outside of a large rotary table. The machine or table remains stationary while each separate mould is being filled, the table is moved by hand, thus constantly presenting empty moulds to the stream of molten slag. As soon as the slag becomes set in the moulds a catch is knocked away and the bottom of the mould drops down upon a hinge and the brick or block falls out. It is then taken into annealing ovens where the temperature is raised to nearly a white heat, after which it is allowed to cool. The high price obtained in the market for these goods enables the company to meet their expenses, but, up to the present time they have not done more than this. The goods they produce are very hard, uniform in size, and look well when laid; but they are liable to crack, particularly in winter, and there are many objections to their being employed as building material. At the Leeds meeting of this Institute, last year, Mr. Bashley Britten introduced to your notice his novel system of making glass from blast furnace slag. Mr. Britten proposed to take the molten slag into a ladle from the blast furnace and to pour it into a Siemens furnace, where certain additions of carbonate of soda and silica are added, according to the quality of the slag used and the glass to be produced. The extensive experiments which have been carried on during the year have proved perfectly successful, and that under the title of "Britten's Patent Glass Company," for which Mr. H. Canning is the secretary, large works are being built at Finedon, in Northamptonshire, to manufacture large quantities of glass bottles. There is one more product from slag; that of slag wool, or, as it is sometimes called, silicate cotton, from its great resemblance to cotton wool. The manufacture of slag wool has often been attempted in England, with partial success. Many years ago Mr. Edward Parry made a large quantity of it in Wales, although in consequence of the injurious effect upon the men it had to be abandoned. The manufacture is now carried on at the Tees Ironworks, and without the slightest inconvenience, either to the men in the yard, or the man who makes it. The process is extremely simple; a jet of steam is made to strike upon the stream of molten slag as it falls from the usual runner into the slag bogies or waggons. This jet scatters the molten slag into shot, and as each shot leaves the stream it carries a fine thread or tail with it; the shot, being heavy, drops into the ground, whilst the fine woolly fibre is sucked into a large tube and discharged into a chamber. This chamber is very large, and is covered with fine wire netting or sieve wire. The steam and air carry the woolly particles all over the chamber—the finest into recesses provided for that purpose; the heavier into the body of the chamber. After each blowing it is selected and taken up with forks and put into large casks or bags for shipment or otherwise. The inside of the chamber represents a most remarkable and curious spectacle after each blowing. The wool is of a snowy-white appearance, and this, hanging all about the inside of the chamber, reminds one of the old and familiar words—

> Great flakes of snow,
> Like fleecy wool.

Slag wool, or silicate cotton, is chiefly employed to cover steam boilers, pipes, &c. Messrs. Jones, Dade, and Co., of London, are the sole agents for its sale, and they have taken out one or two patents for its application. The most noteworthy of these is what they term mattresses. These are about 2ft. to 3ft. long and 1ft. wide, by 2½in. thick. The mattresses are laid upon the boiler or pipes to be covered, and are secured in the usual way. Its perfect incombustibility, combined with its non-conducting and indestructible properties, give this material many advantages over any other for this class of work.

The various forms into which blast furnace slag is being made, and to what purpose it is being applied, are: Slag sand: This is employed for making concrete, building bricks, mortar and cement, for agriculture purposes, and gardening. Slag shingle is being used largely for concrete and for roads and footpaths. Slag wool: For covering steam boilers, steam-pipes, hot-water pipes, fire-proof rooms, ice-houses, cisterns, gas and water pipes, as a protection against fire, as well as for filtering chemicals. Paving blocks: Employed for streets and footpaths, stables, coach-houses, yards, crossings, breweries, and for curbstones and channelling. Building bricks: Made by pulverising the solid slag and then pressing the bricks in a press. Glass by Mr. Bashley Britten's patent process into roofing glass, bottles, gauge glasses, and many other articles for which a pure glass is not absolutely essential.

THE ACTION OF SCREW PROPELLERS.

OUR readers will have observed, that in the notice of the life of Sir J. Smith, the inventor of this great aid to navigation, reference was made to that part of the engineering furniture, but no lengthened description was possible. It happens that Mr. Howden has recently given such an outline as will enable the general reader to comprehend still more clearly the principle on which it works.

"It may be asserted without much fear of contradiction, that during the last quarter of a century little or no progress has been made in improving the efficiency of a screw propeller. Increased experience has, no doubt, led more generally to a better proportioning of the surface and pitch of the blades for any special conditions, but no radical improvement has been made in the form or construction of screw propellers during that period, notwithstanding the numerous efforts to increase the efficiency of the screw as a propelling instrument. It appears to the writer that this lack of improvement and waste of effort has being owing chiefly to the fact that the defects which have been most persistently sought to be overcome, or corrected, are altogether or for the most part imaginary and not real, their conception having arisen from several prevalent erroneous ideas regarding the action of the blades on the water in which they revolve. In the course of this paper I propose to show that the supposed centrifugal action of the propeller blades does not and cannot exist under the ordinary conditions of a propeller at work; also that no large column or stream of water is thrown out from the propelling faces of the blades either backwards or angularly when the vessel if fully under way. The propeller blades in such a case can only in a very slight degree impart any motion backwards or otherwise to the water against which they glide. Experience has pretty fairly shown that screw propellers are now generally made of judicious proportions in regard to the number and surface of their blades, and also as regards their pitch and outline, so that improvement must be sought for in some other direction than these. The chief defects of screw propellers, as now made for ocean steamers, are those, so far as I can discover, which arise from the great weight and thickness it is necessary to make them in order to prevent their frequent breakage. The first and most essential quality in a propeller is that of sufficient strength, and every other desirable quality must yield to this, if their retention is inimical to that on which the very existence of the propeller depends. This great thickness of blade found necessary to give strength, produces, or at least greatly increases, the following serious practical disadvantages:—(1) A large unproductive absorption of the engine power in driving the propeller itself. (2) Retarding the progress of the vessel by increasing, in some ratio of the thickness of the blades, the reduction of the pressure of water under the stern of the vessel. (3) Causing undue wear of the stern bearings in ordinary working, and injurious shaking of the afterpart of the vessel and rudder, and severely straining the propeller-shaft when the vessel is pitching and labouring in rough weather. In considering the first mentioned defect, the undue absorption of engine power by the revolution of the thick blades of the propeller, I do not forget what Professor Rankine, Mr. Froude, and others have pointed out, that submerged ship-shaped bodies, of different sectional areas, but of equal surfaces, will have practically equal resistance, if moved at a velocity which will allow the water to fall in behind as fast as it is displaced forward. Experiments, however, also clearly prove that, at certain velocities, the water will fail to fall in sufficently fast behind such bodies, and the resistances to their motion will then be increased by the diminution of pressure or the formation of a practical vacuum behind them. If we suppose the large body to have twice the sectional area of the smaller amidships, the speed required to form this partial vacuum will be considerably less for the

larger bodies than for the smaller, and after it is formed the resistance therefrom will rapidly increase with each increment of speed. It is likewise a plain deduction that if this partial vacuum behind each body were equal, the resistance to the motion of the body with twice the section would be twice that of the other. Then, as the velocity to produce the same vacuity or negative pressure behind per unit of surface must be much greater in the supposed case of the body with its midship section only half that of the other, we can easily conceive that, at a certain equal velocity, the negative pressure behind the smaller body will only be half that behind the larger body. The actual resistances in these circumstances, and consequently the power necessary to overcome these resistances, will, therefore, be as 4 to 1, the larger section having double the area and twice the pressure of the smaller. I am not prepared to say at what velocity any two bodies having equal surfaces and relative sections, such as I have supposed, would have their respective negative pressures exactly 2 to 1, but it is quite within the range of investigation. I may say, however, I have no doubt that the differences in the thickness of the blades of propellers of equal diameters could be made such that the relative resistances arising from negative pressure may be when working at the same velocity, 4 to 1, if not even of a still greater difference. In order to elucidate the subject more fully, I will take the case of a propeller now in use in a large Atlantic steamer, the consideration of which, under actual working conditions, will also give me the opportunity of referring to the several generally received opinions regarding the action of the screw propeller to which I have already referred. The dimensions of the propeller, I may remark, have been very slightly altered to avoid unnecessary fractions. This propeller has four cast iron blades bolted on a spherical boss in the usual manner. Its diameter is 20ft., and pitch 27·77ft., the boss being 4ft. 11in. in diameter. Each blade has 28 square feet of surface. The whole propeller weighs 17½ tons. When this propeller is driven at sixty revolutions per minute, and the slip is 10 per cent. —a slip which, I may say in passing, is rather over than under the average of the best class of full-powered ocean steam-ships—the direct forward progress of the vessel and propeller is 25ft. per second, or 14·8 knots per hour. This propeller is illustrated at the Works by four drawings, and can be seen perfect as well. In the first the blade is shown on its flat with a section of the boss: in the second it is in section on a diameter of 6 ft. 8 in., or one third the diameter of the propeller. The third shows the propeller sectioned on that diameter, and the spiral passage through the water which would be made by the blades at this diameter in one revolution, the slip being 10 per cent.; and the fourth is a projection of the propeller at right angles to its axis, in section through the centre line of each blade, or what I may term the midship section of each blade. The thickness of each blade, on this line of section, is 1½in. at the point, and 11in. at the root, measuring between the straight lines produced to the extremity at the outer end and to the boss at the other end, not taking notice of the rounding off at the tips, or the filling up curves where the blades join the boss. Let us now consider the various velocities of the blades at different points from the centre of this propeller when working at the speed before mentioned. At 5ft. diameter, or quite close to the boss, the velocity of the blade through the water consequent on its revolution and the forward movement of the vessel is 29·52ft. per second. At one-third, or 6ft. 8in. diameter, it is 32·62ft. per second. At nearly half the distance of the length of the blade from boss to extremity, or 12ft. 6in. diameter, the velocity is 46·55ft. per second; and at the extreme diameter 67·62ft. per second. It must be evident that blades of the thickness shown passing through the water at these enormous velocities are far to full in their section, especially towards the roots, to permit the water to fall in behind sufficiently fast to prevent the formation of a partial vacuity. The section of water displaced by each blade from where it joins with the boss has an area of 4·03 square feet, or 16·12 square feet in the four blades, and in each revolution of the propeller, or per second of time, the amount of water displaced by the four blades is 661·5 cubic feet. The water displaced by the boss must also be taken into account, and in the case before us the area of the boss—4ft. 11in.—less the area of the part masked by the cylindrical boss on the stern post, say of 3ft. diameter, is 11·947 square feet, which, by the actual distance 25ft. passed through by the vessel per revolution, is 298·675 cubic feet per second. The amount of water displaced by the propeller per second is, therefore, 661·5 + 298·675, or a total of 960·175 cubic feet. This great thickness of blade, involving, as it must do, a large amount of resistance, is, however, found necessary to give sufficient strength in cast iron to stand the Atlantic navigation, and the thickness must not be much less when the blades are cast in steel. I now come to consider the matter of slip, and in connection therewith, the extent of the water set in motion backwards by the thrust of the screw, and to compare this with that of the displacement of the blades themselves when working without slip. Were the vessel to maintain a speed equal to the pitch of the propeller, or, in other words, were the screw to propel the vessel without slip, and the propelling faces of the blades a true screw, there would be, and could be, no motion whatever of the water backwards or sideways due to the thrust of the propeller, because no motion would have been imparted in that direction by the revolution of the blades, and the only movement or displacement of the water that would then require to be considered would be that caused by the blades themselves and the part of the boss not masked by the stern post. When slip occurs, however, there is a certain amount of water put in motion backwards by the propelling faces of the blades, but which, when the slip is moderate—as it should be in all properly designed steamers—is trifling in amount when compared with that displaced by the blades themselves in forcing their way through the water. In the case of the propeller under consideration, the actual motion given to any particle of water by the blades at the different diameters already mentioned consequent on the slip, are as follows:—At 20ft., where the blades measure 22in. across on the circumferential line the motion is ·812in.; at 12ft. 6in. diameter, where they measure 53in. across, 2·44in.; at 6ft. 8in. diameter, when the measurement across is 52in., 2·53in.; and at 5ft. diameter, where they are 43in. across, the motion due to slip is 1·83in. The extent of motion due to the slip at any given diameter of the blades is ascertained by dividing the distance passed over by a point in the blade on the given diameter in one revolution, by the length of the arc of the circle on the breadth of the blade at that diameter. The quotient gives the number of times the whole breadth of the blade at that point passes over new surfaces of water in one revolution. Then, as the blade can only act continuously on any one particle of water from the time of its coming in contact with it at its forward or leading edge until it leaves the particle at its after or following edge, the whole extent of the motion which the water receives when in contact with the blade is equal to the whole slip of the revolution divided by the number of times the distance passed over by the blade in one revolution is greater than the breadth of the blade. It must also be observed that the actual slip of the water is less than the slip of the propeller at any given diameter in the proportion of the base to the hypotenuse of a right-angled triangle in which the base is equal to the circumference of the propeller at the given diameter and the perpendicular equal to the pitch of the screw."

MECHANICAL PROGRESS AS RECORDED.

FIVE hundred patents in a month is a fact that will stand a little analysation. The questions arise, What are they about? What can they do? Five hundred a month is six thousand a year; and, seeing that mortality can at least bear the strain of thirty years, there comes a total of 180,000 improvements in one's own poor time; enough to take all a life to look at and little to enjoy.

But it is good to observe the perpetual strife for excellence. What would be our life without it? Improvement is like hope, ever before human eyes enchantingly; and, when like hope it disappoints, begins anew its ever-coursing way. We will take up the thoughts of men of practical science who have been sufficiently brave or who have found good helpers: and to look at one month's supply, so far as that is manifested by the payment for privileges of profit in reward for ideas.

These must be classified; that of Mr. Lyte has reference to a most important subject—the treating mixed ores and residual products. "This relates especially to ores containing zinc, lead, and silver. The ore calcined (perhaps) and pulverised is stirred in a solution of hydrochloric acid heated by a steam coil. When the precipitates have been allowed to settle, the clear solution, holding zinc and other soluble chloride, is decanted into another vessel, where, on cooling, most of the lead chloride is deposited in crystalline form. The supernatent liquid is returned to the attacking vessel, where more lead chloride is taken, and it is deposited as before; this may be done several times. Any silver precipitates with the lead. Bars or filings of lead are added to the liquor containing the precipitate, and the silver and lead are reduced to a sponge metallic precipitate. The zinc chloride solution is neutralised with chalk, and heated to boiling, and elutriated milk of lime is run in. The zinc precipitate is well washed and pressed into lumps for distillation of metallic zinc."

From it we pass to the mechanical, and there we have a water meter of Messrs. Wightman and Ally, which consists mainly of a horizontal measuring drum in the upper chamber, which re-

ceives water at a bearing on one side and acts on counting gear at the other. It has radial divisions forming four compartments, which are successively filled; each has an external stop which acts on a weighted lever to hold the drum during filling of a compartment; the stop at length overcomes the lever and the compartment is emptied into the chamber, whence it overflows through a central passage into a lower chamber, from the bottom of the latter it passes out upwards through a pipe governed by a float valve. In going to the drum the water passes through a check valve, then acts on the under side of a piston in a perforated cylinder communicating with an annular space, whence there is a passage to the lower part of the casing. A small number of holes, however, admit the water into the tube leading to the drum. There are several modifications of this proportional valve apparatus. There are also arrangements for preventing diminution of the quantity of air, renewing the air, &c.

And then on a very important subject there comes a cheap and welcome contribution from Mr. Webb on railway brakes and signals: "The object is to liberate continuous brakes or give notice by whistle or signal to those in charge of a train when approaching a danger signal, by apparatus consisting in arranging a rod in connection with the trigger of the brakes, or the whistle, or gong, and sustaining it by a prop of elastic material attached to the train, and which by coming in contact with a bolt shot out by and actuated with the line signals, is sufficiently bent out of position to allow the rod to drop and the application of brakes or whistle to take place. It also consists in a method of actuating shades before lamps on locomotive engines by means of connections with the reversing lever, so as to show the direction of motion of the train.

Passing onwards, Mr. Jérusalémy especially regards signals, and has a novel method of production: "Fireworks are fired and thrown by means of detonating caps. Communications in railway trains or signals, therefore, are to be made by means of an apparatus provided in the carriage, and containing maroons which may be fired by the passenger pulling and letting go a spring knob, when a loud report is heard by the engine driver; and afterwards a maroon 'describing a curve of about four or five hundred feet in the air will terminate by a second and louder report in front of the engine driver.'"

Leaving the railway world let us look at the general; on which, being *practical*, we are particular. Mr. Weaver has a ventilator which, as applied to large structures, comprises an injector ventilator (fixed in windows, walls, or doors), the outer part being a scrubber with a series of deflecting plates or gills, against which the air impinges, throwing down solid impurities; a stream of water may be admitted at the top. From a reservoir, the air is tilted up by a series of plates with louvre arrangement. The upper part of the inlet is always below the level of the under part of the outlet. Further, an extractor ventilator, consisting of a tube placed in the roof, walls, or chimneys, controlled by a self-regulating counterpoised valve moved by the outgoing current. The exit end, protected by a cone, is at a higher level than the inlet. Modifications are described.

Mr. Weild provides Jacquard cards, a very profitable and useful manufacture, and he says it "consists in pasting together, say, four thicknesses of paper, two forming the upper half and two the lower of the thickness of the card, with bands or tapes of linen or the like, passing across from one card to the other, and forming hinges. Machinery for doing so is described; before the paper and tapes unite, the upper and lower halves of the paper pass over surfaces having slits for punches, which punch slits in each opposite where the tapes come; then paper and tapes pass under a pressure roller, then a knife completes the slit which separates the cards from each other with exception of the connecting tape, and cuts the cards to the proper length."

Then of brushes, Messrs. De Mont & Gane have a specialty worthy of notice. "The tufts are fixed in the stock by means of a small two-pronged piece of sheet iron (the prongs notched exteriorly) called the anchor. When the tuft is in place the sides of the anchor are forcibly separated by a punch, so that the teeth press the back of the tuft against the inside of the hole. The inserter consists of a long steel piece with channel for the punch rod to slide in, and with side openings for the anchor and tuft; the lower part is coned. The anchor is inserted before the wedge-shaped end of the punch, and is pushed down against the tuft (pushed through across), so as to fold it. Anchor and tuft are then driven by hammer into the stock. (A machine for driving the tufts is described.)"

Mr. Hadden helps us on a very troublesome subject—that of ruling machines, and his peculiar excellence is in an arrangement by which "a cylinder under the pens has cams, which are on a lever causing the rise and fall of the pivoted pen bars. Cams at the other end of the cylinder cause a gate, which holds the paper, to drop or rise as required. The pen rest at one end of the pen bar is made crooked, bringing the weight so far below the pivots as to prevent jar. The pen bar is connected to its bearings by universal joints. A metal strip forms a groove for wedging the flannel on the pen beam. On the top of the beam are movable chains, with blocks, plates, and set screws, for holding and adjusting the pens. Cylinders of various diameters are interchangeable, &c."

In regard of building materials, which, by the way, is a very serious subject because the materials of houses are on the spot where the home is to be; and a little knowledge will reveal the method of proving that statement by the result. Mr. Hyatt takes a patent which "consists in very various applications of Portland cement made into concretes or artificial stones in the form of slabs, vessels, &c. Beams are made of cement covering a core of iron either as T or other rolled iron, or in the form of a simple girder. Coloured cement, slabs, &c., are described, and beams made in sections, grates, fire-proof floors and roofs, the latter covered with wood walking surfaces inlaid with glass footways. Mats are made with interwoven glass for transmitting light. Portland cement is substituted for putty for setting glass in sashes. For windows with various forms of glass panes, the glass is pressed to shape and with ridges for securing them to the frame. Reflecting glasses, in which the reflecting surfaces are embedded in a covering of glass to keep them clean, are also, with other things, described."

And then, Mr. Duncan claims his monopoly for the making of bricks, which is thus set forth:—"The brick-making machine consists of a horizontal cylinder with moulds, to which clay is supplied from a pug mill above (with screw knives). The clay in the moulds comes first under a roller at the bottom of a hopper which holds tinting dust, then under a presser formed on a roller driven by a toothed wheel. Next it is carried down into a line with the main pressers, one working outside the other inside the cylinder (their faces kept clean with oil). The bricks, forced partly out by the inside presser, are carried into a pan of enamelling, colouring, or glazing liquid at the bottom, or so as to be opposite a printing block which is actuated to print in colours. Then the bricks are forced out. In the tile-making machine a stream of clay passes from a pug mill through a vertical box (with screw) and rollers (with oil tanks above), and is guided by a fustian-lined trough to the front of a vertical mould, in which it is then pressed by two pressers. The mould turns down through a quadrant, giving momentum to the tile, so that it is delivered to a travelling band. (A pipe-making machine is also described).

But concrete building and tile-facing having come into fashion, Messrs. Henley have a patent which "consists of a revolving and self-fastening apparatus of iron or metal. Standards are formed to any suitable length and thickness of wood, flanged each side with iron having slotted holes 2ft. apart to receive bolts and wall gages or straps. For raising the concrete, a drum on the ground is used along with a fall wheel on the scaffolding. A chain is passed over the wheel, and the two ends are fastened, one on the right side, the other on the left, of the drum. To the double rope are fixed two hooks for parts of concrete; on turning the drum, one part of the chain descends while the other ascends.

As an appendix to building construction, there is the revival of an old idea, but of novel arrangement. Mr. Hill's patent is for making portable buildings "formed of iron, wood, *papier maché*, &c., in duplicate conversion parts, the frames and sections being made to fold, and being applicable for various purposes. Paper and other pulped materials, rendered uninflammable, are used as covering. Structures are made with raised platforms, worked on the lazytongs system. There is also a flooring of ornamented or indented wood blocks laid on pulped material, a raised skating puzzle or maze."

And, lastly, in connection with buildings there is a specific for restoring spent sand; how such prescriptions obtain protection passes knowledge. They can scarcely be called inventions, and yet are unquestionably of commercial value. Messrs. Loynd believe they can be protected, or they would not have paid the fees to tell the world their secret for restoring spent sand, which is, "For 1 cwt. of the sand are taken ¼ lb. of oil of petroleum or other volatile oil, 2 oz. salt, 1½ lb. blue clay, 3 lb. coal dust, 1 lb. charcoal; the whole is thoroughly mixed and let stand a day or two before use."

Electricity attains a further development in Mr. Cromwell Varley's new method of generating that force by a new machine. "A simple form of this magneto-electric machine consists of two horse-shoe magnets placed with like poles opposite each other, and between (and in contact with) the poles two soft iron cores with coils of curved wire. An armature is reciprocated (by a rod) lengthwise between the magnets; at one moment it is in contact or nearly so with the two poles of one magnet, then with the two poles of the other. (The principle is variously applied.)

An electrostatic multiplier described consists of a vulcanite disc rotated on insulated standards, and having radial strips of tin foil on a short width of the face; two collecting combs opposite the strips being electrical to the conductors. Near the other side of the disc are the inductors, two pieces of wood (on insulating standards) covering about a quadrant of the operative point of the disc. Two other combs with contact springs are used for charging the inductors. The multiplier is combined to render the light obtained from the machine constant."

And the steam engine reaches another phase in Mr. Davey's labour, which is described in these terms:—"This relates to a combination of two engines in such a way that either can be worked with steam direct from the boiler, and the other by the exhaust steam of the former, or that both can be worked with steam from the boiler (a compound valve-box is devised for the purpose). An outer and inner reservoir is provided, the outer receiving steam from the boiler and supplying the high-pressure cylinder, the exhaust from which enters the inner reservoir, which supplies the low-pressure cylinder. There is a loaded valve between the cylinders. Again, with a differentially-worked steam slide is combined an expansion slide worked differentially by a lever moved partly in accord with the piston of the engine and partly in accord with the steam slide."

A general observation occurs in all these contrivances—that they are more ingenious than creative. They increase the stock of varieties without proclaiming unknown principles. We fail to discover such application of forms or treatment of substances as in many instances have revealed a new world, or transformed the old one. Here is one by two foreign gentlemen on a sewing and braiding machine which "relates to combination in one machine of a universal feeding mechanism (like that of the Bonnaz machine) with an eye-pointed needle, working with a revolving or reciprocating hook or shuttle or other contrivance for forming a stitch; while the needle follows all the motions of the feeding or presser foot (as in the Bonnaz embroiderer), the needle plate with the hook or shuttle, and shuttle-carrier and apparatus for actuating the same, constantly follow the same axial movements. Thus, the universal feed can be combined with the chain, lock, or other stitch produced with an eye-pointed needle." And another equally ingenious for folding furniture by Mr. Jackson—"The top of a table, *e.g.*, is formed in two pieces made to fold at right angles and form half the sides of a case with another table; the folding legs and struts are packed within. Two joints are described, one (recessed in the wood) for the flat or rectangular position, the other a T-joint. One metal fastener has a latch working on a spring catch, another, of leather, has two ways in it for straps at right angles to each other."

The art of the chemist has a great share in all the advances of science, and is blended with mechanism more and more. In calico printing the well-known name of Chadwick communicates a specification which relates to printing in iodine or methyl greens, blues, and violet colours, either with or without alizarine or madder extract colours. For green, 1 gallon of sumac extract, 1 gallon of acetic acid, 2 gallons of water, and 8 lb. of crystal starch are boiled, and 2 lb. of tartaric acid are added. Then cool and add 12 oz. of methyl green. The colour is then ready for printing. Mr. Cook has a new method of producing bleaching powder, whereby heat is applied to promote absorption of the chlorine by the lime, which is laid in much greater depth and agitated, and Mr. Moody discovers that hyposulphites of soda, potash, or ammonia are manufactured by causing a solution of sulphide of the alkali to trickle over an extended surface, over which a current of sulphurous acid gas is caused to pass.

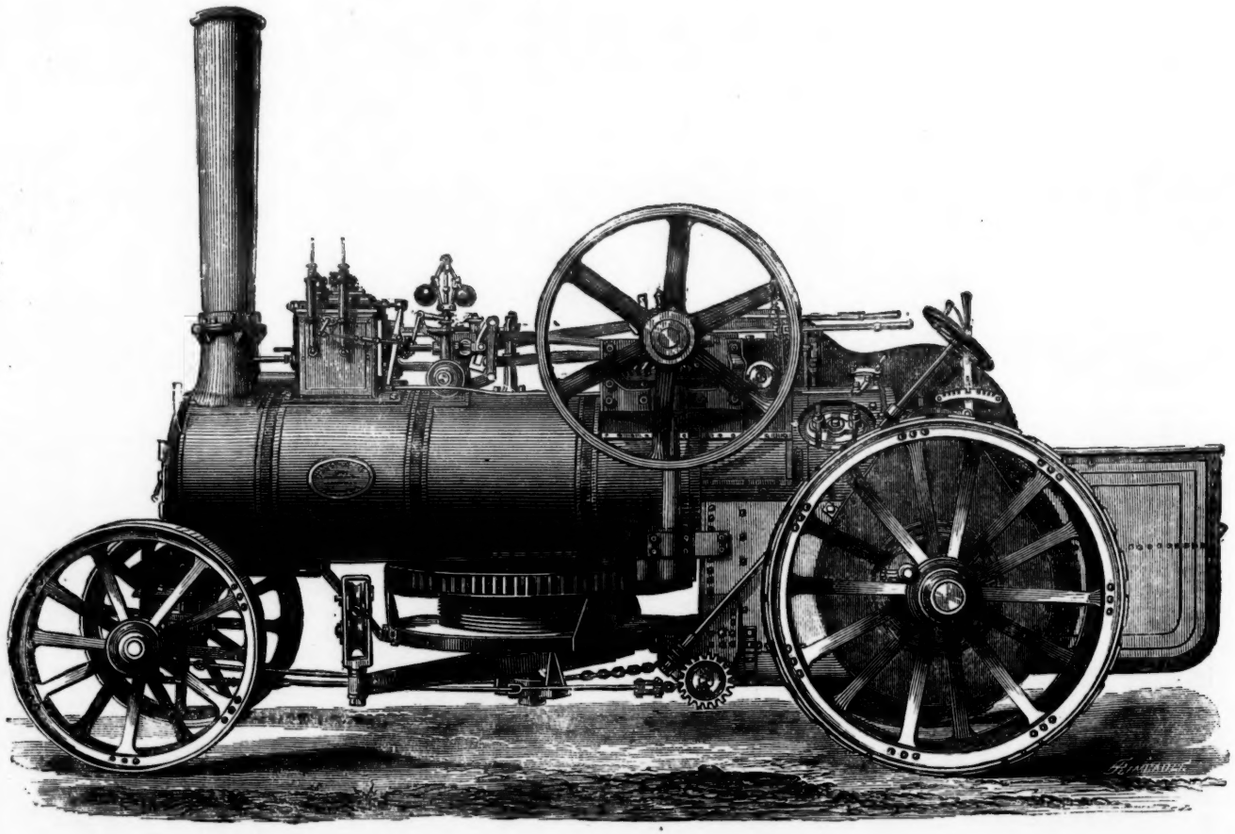
Many of this class are "not proceeded with," such as one for cosmetics or ointment; this consists in mixing vegetable oil with water in which carbonate of magnesia is dissolved with the aid of carbonic acid: and another for incombustible paper—the paper is put into a solution of sulphate of ammonia, sulphate of magnesia, and sodic borate in varying proportions: and another for window blinds—a pendant cord winds on a reel on the roller when the blind is drawn down. It passes below between two india-rubber pulleys (in a box), one of which revolves between two flanges on the other. The blind is held in any required position by pressure of the pulleys, which also allow of the blind being pulled up or down: and another for testing the qualities of malt, which consists of a double cylinder of metal, the inner compartment having a tap, and the outer a syringe, at top, for drawing up water and forcibly ejecting it into the inner to sparge the metal. There is a hole in the lid for a thermometer, and the apparatus is supported on tripod over a lamp or jet: and another relating to the manufacture of playing cards, in which the value-device is printed not only on the central part but on each corner, so that any particular card can be readily seen and selected from the hand by the player: and again one would improve on cruet frames, but it was not worth while to pay more than entrance fees—the frame has a silvered glass base, with back metallic plate and feet. The stem fixed through the centre may be of glass in the lower part: and there follows a Mr. Millington, who also pays for a beetle trap invention, by which the beetles walk up the outer uneven surface and drop into a well (the bait being at the bottom of the trap). The trap, which is of glass, metal, or the like, divides midway, so that the insects can be taken out and the trap well cleaned.

There is a melancholy interest surrounding these abortions: some of them doubtless contain good, but most are obviously in use and, if not, are hardly worth the using. One wonders that trivial matters of the kind should excite the hopes and involve the sacrifices they do, until it is remembered that hundreds of fortunes have been made by these devices. England has many; America now has more of these simple monopolies, that for ten or fifteen years yield a revenue sufficient for a comfortable home.

Finally, we will select a few belonging to domestic life, or rather to the ordinary household. These are mechanical, and as they have been "completed" there is a prospect of their success. Beginning with Mr. Watson's method of scoring billiards, which consists in making numerals on an endless belt, and by making an aperture in a second endless belt which passes also round drums, round the first covering it. The aperture is brought in succession over the numerals, exposing one at a time. The two driving drums at each end are connected by toothed wheels, so that the belts are moved in opposite directions. Again, one row of numerals is made to answer for both spot and plain pointers, one pointing upwards, the other downwards; the pointers are moved by screws acted on by ratchet wheels and click at the ends. Or the single row of numerals may be marked on a dial having two pointers. Mr. Cole has a divice for extinguishing lamps, which consists of a metal extinguishing-case fitted over the wick case, with a mouth at the upper part which is caused by a steel spring to close over the wick, when the extinguishing case is moved up above the lighted wick by a rack and pinion; the mouth opens as the extinguisher is moved down again. Mr. Kerry has a new polish, composed of rectified spirits of turpentine 4 oz., alcohol or spirits of wine 1½ oz., salt of tartar 2 drachms, essential oil of lavender 6 drops, water 1 oz., mixed at a temperature of 75 deg. and used for jewellery and furniture. Mr. Bounes would improve on the floating night lights by the use of a small saucer of metal or porcelain, with tube in the centre, enclosing another glass tube which forms the burner. The vessel is made heavy enough to sink a little in the oil on which it is floated: and Mr. Schroll makes a pencil that will neither rub or wash out, and consists of a combination of nitrate of silver with clay earth and black-lead, or other colouring matter. Linen is damped and written upon with the pencil, then ironed.

Our foot clothing, from which most persons derive infinite misery, has also a share in the inventive efforts of modern skill. Mr. Wright gives a superior fastening of buttons to boots which consists in passing a staple, or metal strip, through the shank of the button, then through the boot material and a washer, the ends being folded over the outer edges of the washer so as to be between it and the boot material. Mr. E. Morris tells us how to improve heel tips by a metal plate, of the form of the heel, but with ornamental hole in the centre, and lugs, not of full thickness, projecting inwards, is fixed by screws which pass through the latter. A piece of leather, corresponding to the hole, is then attached by points or blinders to the body of the heel, covering the lugs. Then we are taught by Mr. Lake how to improve saws, and his invention relates to production of saws tempered and brought to their ultimate form without hammering; it comprises adjusting the fast and the loose in a saw, by throwing the heat on the centre or outer edge or any desired part, perforated formers for tempering and forming articles of steel in a heated oven in combination with a blower, a distributor, with flues and dampers; and Mr. Cook, junior, devises an improvement on steam planing tools. The cutting irons are shaped with a helical twist, and fixed on the sides of the spindle, which is square in section and twisted. As one iron is finishing, the other is coming into action. A mode of sharpening the iron with, *e.g.*, an emery wheel is described. Mr. Angell enlightens us on the formation of wood screws. By his plan the thread is formed with a differential pitch and a variable depth, pitch and depth having a constant relation to each other. The cone is of the same length between any two threads, whatever their pitch. (The pitch may be made uniform in one portion). The method of cutting consists in giving the tool a feeding motion towards the axis of the blank as the pitch increases in speed.

This is a cursory notice of what has been done in less than one month. These patents numbered nearly 6000 last year,



and this year is heavier. The revenue is over £100,000 clear profit; and there is no doubt but that even great as are our attainments, the increase will be manifest year by year. We have only given a sample, but it is an interesting and curious practical study.

STEAM PLOUGHING MACHINERY.

WHEN one remembers the Swing riots evolved from the ignorance of the people in respect of the beneficial or other characteristics of machinery, and the tremendous destruction of hayricks and cornstacks that ensued, and puts in contrast the wondrous fact that machinery has been the best friend of agriculture, there arises a little difficulty in the way of treating and rebuking those who were ignorant, and those who would not learn.

That difficulty has been solved by circumstance. The farmers would not know; and the labourers declared they should not learn. Neither would the workers learn. They could insist on having half-a-crown a day, and they determined to be undeprived of their industrial reward. The machines were broken and abused, but the wages did not go down! The wages rose, and the trouble that remained consisted in finding men who would learn the modern and easier modes of earning a livelihood. There stood the machinery and the guides, and there stood the helpless ones. Often and often has the lesson been told and often been repeated. It must be learned. Time and circumstance dictate to mankind, withal its conceit, that man independent is not fit to rule. The entire range of agricultural life exemplifies the soundness of this conclusion. And science, in her own researchful intercourse with the secrets of nature, science, and art, illustrates the fact of human impotence in all the realm of knowledge, unless the man-student will be child-like, obedient in his tendency and disposition.

Modern knowledge, and our insular condition, told us, and all the world that "Till's Husbandry" and fallow years would never do any more good. Man had no occasion to dig when science taught him how to avoid the toil. The soil needed no fallowing when chemistry taught how to make three crops a year by transposition, and acquire three revenues to the good of the land! Such ideas were new. Three crops, and the land improved, meant a trebled income at a very small outlay, and that assumed not only an aspective but a positive force for his obedience thereto, threw the fallow policy to the winds, and made a glorious opening for the labourer's prosperity and hope.

Then came the steam engine. That mighty principle took a very early form in dictating to mankind its claim to respect and obedience by allying itself to agriculture.

Savory, some thirty years ago, produced a system somewhat akin to the old Blackwall Railway. By it, an engine made for rope-winding was placed on each side of a field, and the engine on the one side wound up a rope that crossed a field which rope the other engine unwound. A plough was attached to that rope and drawn from one side to the other alternately, each advancing a short distance along the field for every cut made. That was modified, so that two ropes and two ploughs simultaneously crossed the field, and with two engines; thus the time of engine work became economised.

Fowler improved on this method by his ploughing machine, in which two drums rotated on vertical axes beneath the boiler on one of which the engine wound up the wire rope, drawing the frame of ploughshares, while the engine at the opposite side of the field was winding up the other rope, and, of course, unwinding the follower. It was really an endless rope and needed not two engines.

Ransome & Simms made a combined engine which obtained a deservedly high reputation, and their engine had some improvement in the patent of Messrs. Beddell & Balk, which they bought up, but still in small farms and in stiff lands, something much simpler became indispensable. Science can always find what man requires; what man believes to be indispensable,—she will, like a faithful servant and a divine instructor, supply. Those who have watched the growth of ploughing machines must be convinced that the verdict of the Liverpool Agricultural meeting in June was a sound decision, when it gave the award for simplicity and completeness to the singularly simple because uniquely combined machine of Messrs. Burrell, of Thetford, which we illustrate and describe. The principal peculiarities about it are its small width—it is only 7ft. 3in. wide, although the tires of the driving wheels have a breadth of 20in.—a reversible fore-carriage, which can be turned round to lengthen the wheel base when the ploughing drum is removed, and a small drum mounted on the driving axle and carrying 80 yards of steel wire rope, which can be used to help the engine out of a hole, to work a derrick, and for many other purposes.

The steam jacketed cylinder is 9in. diameter. The piston stroke is 12in. There are 30·5 square feet of fire-box, 140·5 square feet of tube surface. The fire-grate has an area of 5·25 square feet.

The engine stands low, and is very compact; steel has been freely used, and all wheels having heavy strains put on them are kept close up to the bearings. The workmanship is excellent. When the ploughing drum is taken off a very efficient traction engine remains; and we have thus an engine well adapted for general use as a ploughing engine in winter, a thrasher in autumn, and a traction engine in summer. The engine we illustrate is one of a pair built for ploughing on the double system, but the design can of course be modified to work on the single system if required.

LOCOMOTION BY STEAM ON COMMON ROADS.

FIFTY years have passed since this began to agitate and interest the public mind, and the generation which modern folk sometimes speak of in a disparaging tone were riper at that date than are we with all our wondrous discoveries, advantages, and opportunities. They had invented and applied all the apparatus belonging to railways, and several lines were constructed and in humble working order. The idea of applying steam for ordinary stage-coaches had its encouragement from a desire to utilize the old roads, and, it must be confessed, thereby to rival the iron road. Rivalry was the rock on which the ship stranded, but as one wrote then "there is good reason to believe that when they come to be regarded as auxiliaries or feeders to the great lines of railway, they may aid and support the development of traffic which may be in itself too limited to require the more perfect means of conveyance, and will be favourably regarded by the public."

The difficulties that prevented the profitable introduction of steam locomotion on turnpike roads were less mechanical than individual. The idea was not in good hands, and had not judicious management. Exaggerated statements were industriously promulgated throughout the country, and assurances of profit recklessly made: the animal world, so far as horse flesh was concerned, would be discharged from vehicular service in the public interest, and the *elemental*, for such was the cant term, became the universal power in general travelling.

Into the question of rival inventors we are not bound to enter. In one notice of Messrs. Merryweather's splendid results allusion has already been made to the claims of Hancock, Gurney, and others. These can all be dismissed by the recital of a story of the first steam carriage, which was made by John Theophilus Cugnot, a native of Lorraine, and in 1763 exhibited his model to the Comte de Saxe. He afterwards removed to Paris, and acquired the patronage of the Duc de Choiseul, who enabled him at the public expense to construct a large steam carriage. It was tried in the following year, but "it moved with such force as to overturn a portion of wall which was opposed to its progress." This circumstance led to the supposition, that the new power was not under sufficient control for practical purposes. That machine was deposited in the museum of the arsenal, and is now in the *Conservatoire des Arts et Metiers*.

However, such an idea could not be suppressed. It instructed English speculators and English engineers. We think that a notice of the expired patents concerning the English adaptations will be of interest. The general idea is now public property. Special patents apply to special improvements, and as the public attention has again been attracted to the project of steam locomotion on common roads the detail of what was done fifty years ago cannot fail to be acceptable.

In 1828 Mr. Goldsworth Gurney completed a steam carriage on a new principle, which we shall proceed to describe:—First, as to its safety, upon which point the public were sceptical. It was stated that, even from the bursting of the boiler, there was not the most distant chance of mischief to the passengers. This boiler was constructed upon a plan totally distinct from anything previously in use. Instead of being a large closed vessel on both sides, with the exception of the valves and steam conductors, which a high pressure or accidental defect may burst, it was composed of a succession of welded iron pipes, perhaps forty in number, screwed together in the manner of common

gas pipes, at given distances, extending in a direct line, and in a row, at equal distances from a small reservoir of water, to the distance of about a yard and a half, and then curving over in a semi-circle of about half a yard in diameter, returning in parallel lines to the pipes beneath, and to a reservoir above, in form that of an inverted horse-shoe. This horse-shoe of pipes, in fact, formed the boiler; and the space between, the furnace; the whole being enclosed with sheet-iron. The advantages of this arrangement are obvious; for, while more than a sufficient quantity of steam was generated for the purposes required, the only possible accident that could happen would be the bursting of one of these barrels and a temporary diminution of the steam-power of one-fortieth part. The effects of the accident could, of course, only be felt within its own enclosure; and the engineer could in ten minutes repair the injury, by extracting the barrel and plugging the holes at each end; but the fact is, that such were the tests to which these barrels were subjected, before used, by the application of a steam pressure 500 times more than could be required, that accidents were scarcely possible.

Mr. Gurney, who was educated a medical man, made the construction of the human body, and of animals in general, the model of his invention. His reservoirs of steam and water, or rather *separators*, as they were called, were the heart of his steam apparatus, the lower parts of the boilers the arteries, and the upper pipes the veins. The water, which was the substitute for blood, was first sent from the reservoir into the pipe—fire soon produced steam, which ascended through the pipes to the upper part of the reservoir, carrying with it a portion of water into the *separators*, which, of course, descended to the lower part, and returned to fill the pipes which had been exhausted by the evaporation of the steam—the steam above pressing it down with an elastic force, so as to keep the arteries or pipes constantly full, and preserve a regular circulation. In the centre of the *separators* were perforated steam pipes, which ascended nearly to the tops; these tops being, of course, closed so as to prevent the escape of the steam. Through these pipes the steam descended, and was conducted by one main pipe under the carriage to the end of the platform, which was, in fact, the *water tank* where it turned under, until it reached two large branch pipes communicating with the cylinders, from which the pistons move and give motion to the machinery. The cranks of the axles are thus set in action, and rotatory movement given to the wheels. By the power thus engendered a pump is worked, which by a flexible hose, pumped the water into the boiler, keeping the supply complete. The tank, 60 gallons, and furnace held sufficient water and fuel for an hour's consumption.

The vehicle resembled the ordinary stage-coaches, but larger and higher. Coke or charcoal formed the fuel by which means smoke is avoided: the flues were above the level of the seated passenger, and the motion of the carriage dispersed the heated rarefied air from the flues. The carriage held six inside and fifteen outside passengers, independent of the guide, who was the engineer. In front of the coach was a very capacious boot; while behind that which assumed the appearance of a boot was the case for the boiler and the furnace. The length of the vehicle, from end to end was 15 feet, and, with the pole and pilot wheels, 20 feet. The diameter of the hind wheels was 5 feet; of the front wheels 3 feet 9 inches; and of the pilot wheels 3 feet: a treble perch supported the machinery, beneath which were two propellers; these were, in going uphill, set in motion, somewhat similar to the action of a horse's legs under similar circumstances. In descending a hill a break fixed on the hind wheel increased the friction; but independent of this, the guide had the power of lessening the force of the steam to any extent, by means of a lever at his right hand which operated upon what is called the *throttle valve*, and by which he stopped the action of the steam altogether, and effected a counter vacuum in the cylinders. By this means he regulated the rate of progress on the road, going at a pace of two miles or ten miles an hour, or quicker if necessary. By another lever he could stop the vehicle *instanter*, and reverse the motion of the wheels as with the paddles of steam-vessels. The guide, who sat in front, kept the vehicle in its proper course, by means of pilot-wheels acting upon the pole, like the handle of a bath chain.

The weight of the carriage and its apparatus was estimated at 1½ tons, and its wear and tear of the road, as compared with a carriage drawn by four horses, one to six. When the carriage was in progress the machinery was not heard, nor was there so much vibration as in an ordinary vehicle, from the superior solidity of the structure. The engine had a twelve-horse power, but was increased to sixteen, but the actual power, except in ascending a hill, only eight horses.

He made several excursions with his new carriage, one of which, from his manufactory in Regent's Rark to Edgeware, was thus described by a gentleman who accompanied the vehicle during the whole of the day:—"On leaving the manufactory, we proceeded at the rate of twelve miles an hour, through Kilburn, on the Edgeware Road, and having gone six miles in thirty-five minutes, we stopped to take in a fresh supply of water. The road being exceedingly heavy, the expenditure of steam was proportionally great, especially on the rising ground; but so far from the carriage being unable to proceed through impediments of loose roads, as stated by some, *we travelled more than five miles an hour at the slowest pace uphill, and other times at the rate of fourteen or fifteen.* On the road home, our stock of water was exhausted earlier than was calculated, through a leakage in the supply pipe from the tank, but no accident or difficulty of any description, beyond the necessary delay from this cause, occured during the whole journey." The consumption of fuel was by no means so much increased as might have been expected from the extra power of the engine, (equal to twelve horse-power) required to overcome the resistance of a loose gravelled road; and an eight or nine horse-power is fully sufficient on a moderately good road. The evolutions and perfect command of the vehicle by the engineer, left no kind of doubt in the mind of scientific men respecting the application of the carriage as a stage coach.

Chemistry applied to the Arts, Manufactures, etc.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF SOCIETIES, ETC.

New Mercury Ore.—At a recent meeting of the New York Academy of Sciences, Mr. F. Kurz called the attention of the society to a new mercury ore from Mexico, which upon analysis was found to contain sulphur, selenium, mercury, zinc, cadmium, and iron. It is a species of cinnabar remarkable for containing selenium to the extent of 18 per cent. in its composition, and was called *guadalcazarsite*, from the location in which it was discovered. It is found in considerable masses and could be treated like the ores of mercury.

Electrical Selection.—At a recent meeting of the Physical Society, Dr. Guthrie and Mr. Akroyd communicated a paper on electrical selection. When a metal or other body is rubbed against some non-conducting substance like caoutchouc electricity is developed, and the track of the metal, although invisible, may be readily made evident by sprinkling on the caoutchouc a mixture of red-lead and sulphur. This sieving, as is well known, imparts negative electricity to the sulphur and positive to the red-lead; hence, by a kind ofelectrical selection, that particular ingredient of the mixture is drawn to the metal track which possesses the opposite kind of electricity. Iron, for example, when rubbed against caoutchouc generates negative electricity, and, after sprinking the powder, the iron track is revealed by the marked collection thereon of red-lead. A list of mixtures was given which may be used instead of the above, and it was shown that electrical selection may prove of use (1) in making an electrical selection diagnosis of the metals, (2) in certain experiments where the quadrant electrometer is objectionable, and (3) in teaching, where this instrument is often unavailable on account of its cost.

Gold Dust.—Twenty-five years ago Mr. Eckfeldt, who was then Assayer of the Philadelphia Mint, submitted the deposit or dust upon the roof of that establishment to an assay, and extracted an ounce of standard gold from 380,100 ounces of dust. A few weeks ago this experiment—says the *Philadelphia Evening Telegraph*—was repeated by direction of Governor Pollock, and a quantity of dust amounting to 1732 lb. was removed. This has just been submitted to the usual process, and has yielded 42 ounces of standard gold, and 96½ ounces of standard silver, a total of about 850 dols. Every week the floors of the building are carefully swept and the accumulation preserved, and once a year, prior to the winding up of accounts, the woodwork of the refining-room and the gloves of the *employés* are burned to ashes. This, together with the accumulated sweepings, is conveyed to the sweep cellar, where it is ground in a mill and sifted and washed in a machine, the pulverised metal being caught up by mercury. The residue of the dirt is then dried, barrelled and sampled, and sold to sweep smelters, who purchase it at the rate of 15 to 25 cents per lb., according to the amount of pulverised metal contained in the samples. So far this year about 260 barrels have been sold, a large proportion of which was purchased for a London firm.

Purification of Water.—An eminent French chemist, M. Gérardin, has, according to *Cotton*, published a pamphlet in which he maintains that the causes which render water good or bad for manufacturing purposes have no relation to its purity, but that water largely impregnated with sewage matter is frequently possessed of important manufacturing qualities, while the pure water of artesian wells is much inferior in industrial value. He gives the following curious instances in point :—A person at St. Denis, who employs the muddy waters of the Groult, which marks 74 deg. of the hydrotimetre, for washing wool, failed completely when he tried to adopt the water of an artesian well, which was perfectly limpid, and marked only 44 deg. A manufacturer of gelatine, at Paris, was stopped in his work one day, when the water company, which had formerly supplied him with Seine water, changed it, at his request, for the pure water of the Vaune, lately brought to the capital. Once the fact was ascertained, the Seine was supplied as formerly, and the manufacture proceeded as usual. M. Gérardin says that the industrial value of water depends greatly on the facility with which it deposits matters contained in suspension. Testing with milk of lime, the best water for manufacture is that in which the lime is deposited the most rapidly. The best manufacturing qualities are never found, he says, in water which gives much bubbles or foam. If water which is found suitable for manufacturing purposes be examined by means of a microscope of at least 1000 diameters, it will be seen that the particles left in suspension are inert, or only affected by gravity, while water found unsuitable for industrial purposes seems animated by a gyratory influence which overcomes gravity, and keeps them in constant suspension. M. Gérardin gives this movement the title of "Brownien," after the English botanist, Robert Brown. This gyratory movement may be destroyed by the introduction of organic matter, &c., in the state of putrefaction, and then it becomes easy of decantation, and, in the industrial sense good water. On the other hand, he has not found the means of giving the gyratory motion to any water which does not already possess it. The curious inference drawn from these facts is that sewage water, and the waste water of certain factories which are turned into rivers, while they corrupt the waters of such rivers as regards potability, endow them with important manufacturing qualities. Thus, the water of the Seine above and in Paris, which are relatively valuable for manufacturing purposes, are still more so after the contents of the great sewage collector has been emptied into them; while, it may be observed, the ponderable matter becomes deposited within a very short distance.

Oxygen in the Sun.—At a meeting of the American Philosophical Society, held in Philadelphia in July, Professor Henry Draper, of New York, read a paper on his "Discovery of Oxygen in the Sun by Photography, and on a new theory of the Solar Spectrum." The coincidence of bright lines of bands in a photograph of the solar spectrum of air was clearly shown by photographs accompanying the paper, and fully set forth in the text. According to Professor Draper—"Oxygen discloses itself by bright lines or bands in the solar spectrum, and does not give dark absorption lines like the metals. We must, therefore, change our theory of the solar spectrum, and no longer regard it merely as a continuous spectrum with certain rays absorbed by a layer of ignited metallic vapours, but as having also bright lines and bands superposed on the blackground of continuous spectrum. Such a conception not only opens the way to the discovery of others of the non-metals, sulphur, phosphorus, selenium, chlorine, bromine, iodine, buorine, carbon, &c., but also may account for some of the so-called dark lines, by regarding them as intervals between bright lines. It must be distinctly understood that in speaking of the solar spectrum here I do not mean the spectrum of any limited area upon the disc or margin of the sun, but the spectrum of light from the whole disc. I have not used an image of the sun upon the slit of the spectroscope, but have employed the beam reflected from the flat mirror of the heliostat without any condenser." Professor Draper's discovery may be considered as three-fold ; first, that there are bright lines or bands in the solar spectrum ; second, that certain of these lines coincide exactly with the known oxygen lines in the spectrum of air produced by the electric spark ; and third, that others of them probably coincide with the lines of the metalloids, or may be referable to unknown substances. Hitherto the presence of oxygen has not been discovered in the sun, although its existence might have been suspected on purely theoretical considerations.—*Polytechnic Review.*

Phosphorus in Iron.—The Society for the Advancement of Industry in Berlin offered a prize of 1500 marks for a quick method of giving accurate determinations of phosphorus in ores, iron, and steel, and awarded it to Herr O. Korschelt, professor of chemistry in Yeddo, Japan. His method gives perfectly accurate results. The following is a short description of the manipulation :—Iron or iron ore in the finest form is gradually added to as little concentrated nitric acid as possible, which is kept boiling. About as much iron is taken as will make the yellow precipitate weigh 0·5 to 0·75 gr. One gramme is necessary when the iron contains one per cent. of phosphorus. Then the solution is filtered into a solution of molybdic acid, which is heated in a water bath. One should never let the solution of iron amount to over 50 c.c. and should wash with water containing nitric acid. If the percentage of phosphorus is approximately known in the iron to be analysed, then one will know about how much solution of molybdic acid will be required ; if the percentage of phosphorus is unknown then take 30 c.c. These precipitate the phosphorus completely out of a solution of one gramme of iron containing one and three-fourths per cent. of phosphorus. Then test whether it is necessary to add more molybdic acid, by pouring out a small quantity of the solution. The yellow precipitate which covers the solution as a film is held back with a glass, or the dish is held obliquely, whereby the film draws to one side, and then some of the solution is taken with a pipette. After a complete precipitation, heat for a short time, filter through the weighed filter, wash with water containing nitric acid, two or three per cent., and alcohol, and then place in a drying apparatus, which is heated to 120 or 130 deg. In twenty minutes the filter is dry and is then weighed. If washed well with alcohol the precipitate has kept its yellow colour. The weight of the precipitate is multiplied by 0·0173, as its contents in phosphorus amount to 1·73 per cent., and then the percentage is calculated. When the solution does not make special difficulties, Korschelt states that his method takes from four to five hours ; whereas others take from one to two days.

Natural Moisture.—The *Colonies and India* tells us of a wonderful vegetable production possessing remarkable properties. It can absorb the moisture of the atmosphere, which it concentrates, and subsequently pours forth from its leaves and branches in a perfect shower, and in such quantity that in many cases the surrounding soil is converted into a bog. We are further informed that it possesses this singular power to a greater degree during the hot dry weather, when the rivers are at their lowest and the water most scarce. It has been suggested to the Peruvian Government, by a gentleman who has examined these trees, that the experiment of their culture in the more arid parts of that country should be made with a view to the benefit of agriculturists.

Oxalic acid from Parchment Waste.—The waste left after the manufacture of ordinary paper is used for paper making, but the raw material used for manufacturing parchment paper furnishes a considerable quantity of refuse after the sulphuric acid treatment, that is not fit for paper making nor is it combustible. Parchment paper is made from pure rags, and Mr. C. O. Cech, in *Dingler's Journal*, proposes to use this waste material after lixiviation in caustic potash for the preparation of oxalic acid, for which he contends it is more fit than sawdust or beet pulp.

Strong Adhesive Paste.—Fr. Sieburger writes a recipe for this useful but despised compost. Four parts, by weight, of glue should be soaked for several hours in 15 parts of water, and then be slowly warmed until a perfectly clear solution results. This solution is then diluted with 65 parts of boiling water and thoroughly stirred. In the meantime 30 parts of starch are stirred into 200 parts of cold water, so as to form a thin, miky liquid, free from lumps. Into this is poured the solution of glue, stirring continually and heating. When cold add 10 drops of carbolic acid. Paste made in this way possesses extraordinary adhesive power as regards leather, paper, pasteboard, and the like. If kept in close vessels so that the water cannot evaporate, it may be preserved for years. Where no great strength is requried, ordinary flour or starch paste is used, and a little carbolic acid added to prevent its turning sour.